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SEARCH LIGHTS OF THE DEEP

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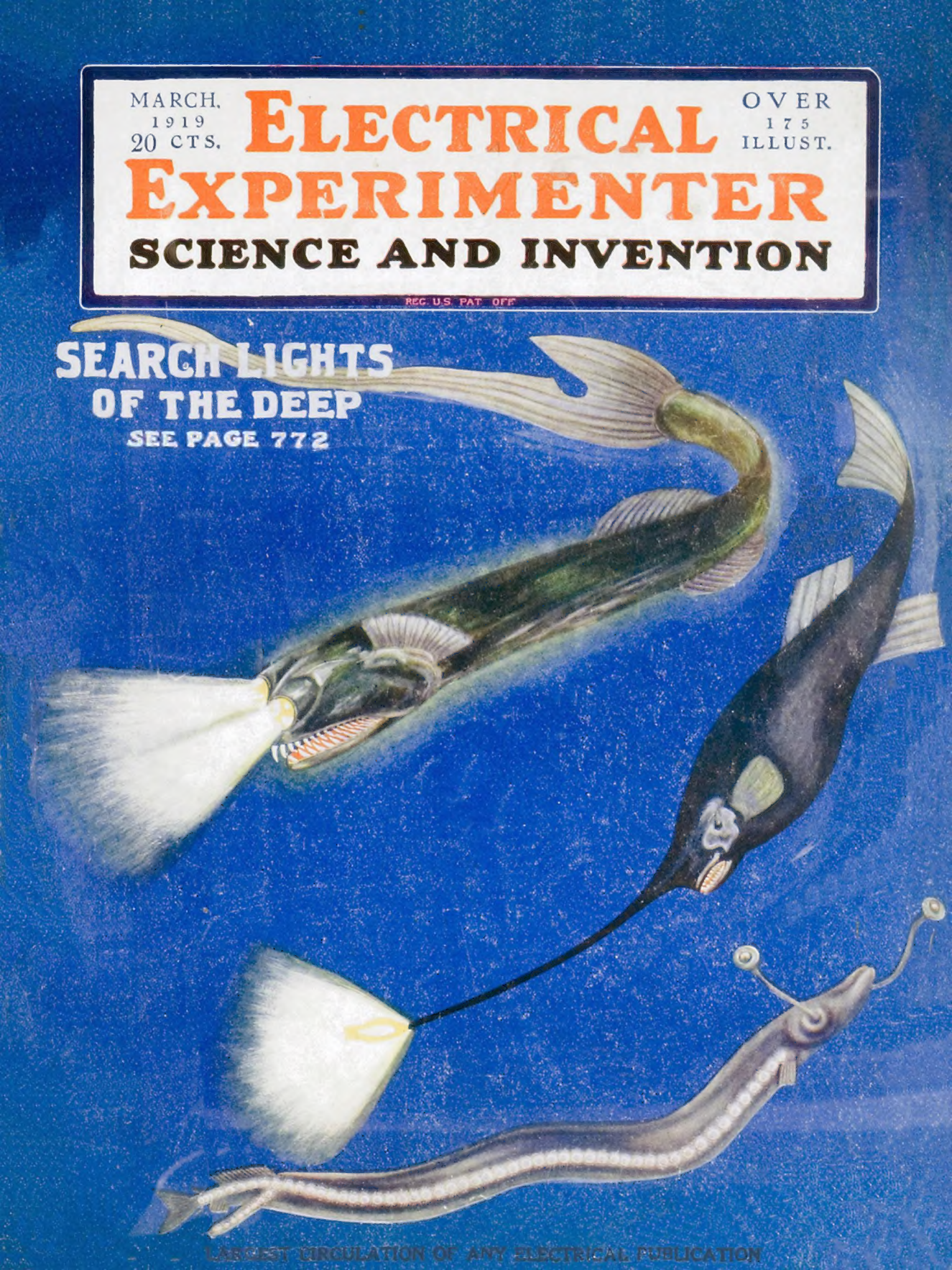

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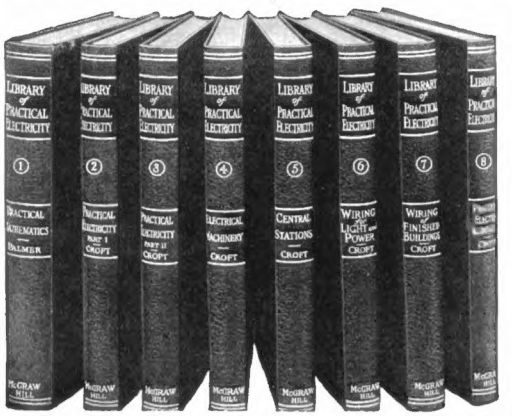
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EDITORIAL

Underground Wireless

ELSEWHERE in this issue is disclosed in full detail for the first time what U. S. Navy officials term as the greatest American War Invention: "Underground and Sub-sea Wireless."

Last month we hinted editorially on the theoretical aspect of the problem—this month we are face to face with the accomplisht fact. The war has revolutionized not only peoples, nations and the whole world, but many hitherto unshakable scientific institutions as well. For over twenty years the wireless aërial—the elevated aërial wire system—was synonymous with the wireless art. The great radio station, the trans-atlantic liner, could not well be imagined without its ubiquitous stretch of elevated wires. The greatest pride of the radio amateur, the aërial on top of his house, which to him was symbolic of the young art, is doomed. This change has been brought about over night by the magic wand of science and her servant—Mr. James Harris Rogers, American, of Hyattsville, Md.

The aërial wires, down for the duration of the war, will never go up, at least as far as amateurs and private stations are concerned. As for the commercial stations, their towers too are doomed shortly for the scrap-heap. During the war Mr. Rogers developed underground and sub-sea wireless—for receiving at least—to a heretofore undreamt of state of perfection. His receiving station at Hyattsville never mist a word transmitted from French, English, Italian as well as German high power stations. *He received his messages from Europe when a thunderstorm, accompanied by terrific lightning, was going on directly above his head.* Recently, too, *he has done away entirely with static.*

When the big station at Arlington, near Washington, was out of touch with Europe, due to static disturbances, Mr. Rogers went right on receiving over his buried underground wires, just as if static never existed. Indeed the Rogers invention knows no static. Static being an atmospheric condition, a ground antenna naturally will not be affected by it.

But the most spectacular feature of Mr. Rogers' revolutionizing invention probably is his "Sub-sea Wireless." Scientists the world over, Marconi included, declared it an utter impossibility to communicate by wireless with a totally submerged submarine. Mr. Rogers, however, goes right ahead and does it, not only in fresh water *but thru salt water as well.* Indeed he establisht wireless communication with a submarine *whose aërial wires were 25 feet below the surface of the ocean!*

Altho Mr. Rogers, during the war, gave most of his attention toward receiving messages, he has made considerable progress in underground radio transmission as well. His experiments prove conclusively that, while underground radio receiving is here to stay, underground sending too will soon be practical enough, even for high power stations. It is merely a question of good insulation at present, and the end of this year, we are quite confident, will bring the solution of the problem. The Navy Department has just succeeded in transmitting a distance of 50 miles with the underground system.

At first it would seem reasonable that only long wave lengths could be used with the Rogers system. But this is not the case. Underground Radio-telephone messages, seven miles distant, come in just as clear on 300 meters wave length as does the Nauen (Germany) station with 12,600 meters wave length. This indeed is good news for our amateurs.

But in the meanwhile, all of our pet theories on wireless are thrown in a sad chaos. For we do not know as yet how the Rogers system works. We can now expect a war to the knife between our wave-propagation theorists and the new school of ground-impulse savants. Mr. Rogers himself takes the view—and he is seconded by Tesla—that the transoceanic messages which he receives over his underground system *are not Hertzian waves*—pure or even converted—but merely high frequency ground impulses.

The future may tell us which school is right.

H. GERNSBACK.

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How One Evening's Study Led to a $30,000 Job

A Simple Method of Mind Training That Any One Can Follow With Results From the First Day

By a Man Who Made Formerly No More Than a Decent Living

I HOPE you won't think I'm conceited or egotistical in trying to tell others how I suddenly changed from a comparative failure to what my friends term a phenomenal success.

In reality I do not take the credit to myself at all. It was all so simple that I believe any man can accomplish practically the same thing if he learns the secret, which he can do in a single evening. In fact I know others who have done much better than I by following the same method.

It all came about in a rather odd manner. I had been worrying along in about the same way as the average man thinking that I was doing my bit for the family by providing them with three square meals a day, when an old chum of mine, Frank Powers, whom I had always thought was about the same kind of a chap as I, suddenly blossomed out with every evidence of great prosperity.

He moved into a fine new house, bought a good car and began living in the style of a man of ample means. Naturally the first thing I did when I noticed these things—for he had said nothing to me about his sudden good fortune—was to congratulate him and ask him what had brought the evident change in his finances.

"Bill," he said, "it's all come so quickly I can hardly account for it myself. But the thing that has made such difference in my life lately began with an article I read a short time ago about training the mind.

"It compared the average person's mind to a leaky pail, losing its contents as it went along, which if carried any distance would arrive at its destination practically empty.

"And it showed that instead of making the pail leakproof most of us kept filling it up and then losing all we put into it before we ever reached the place where the contents would be of real use.

David M. Roth

When Mr. Roth first determined to exchange his leaky mind for one that would retain anything he wanted it to, it was because he found his memory to be probably poorer than that of any man he knew. He could not remember a man's name 20 seconds. He forgot so many things that he was convinced he could never succeed until he learned to remember. Today there are over ten thousand people in the United States whom Mr. Roth has met at different times—most of them only once—whom he can instantly name on sight.

Mr. Roth can and has hundreds of times at dinners and lectures asked fifty or sixty men he has never met to tell him their names, businesses and telephone numbers and then after turning his back while they changed seats, has picked each one out by name, told him his telephone number and business connection.

These are only a few of the scores of equally "impossible" things that Mr. Roth can do, and yet a few years ago he couldn't remember a man's name twenty seconds. Why go around with a mind like a leaky pail when, as Mr. Roth says, "What I have done any one can do."

"The leak in the pail, the writer demonstrated, was forgetfulness. He showed that when memory fails, experience, the thing we all value most highly, is worthless. He proved to me that a man is only as good as his memory, and whatever progress a man accomplishes can be laid directly to his powers of retaining in his mind the right things—the things that are going to be useful to him as he goes along.

"Farther on in the article I read that the power of the mind is only the sum total of what we remember—that is, if we read a book and remember nothing that was in it, we have not added one particle to our experience; if we make a mistake and forget about it, we are apt to make the same mistake again, so our experience did not help us. And so on, in everything we do. Our judgment is absolutely dependent on our experience, and our experience is only as great as our power to remember.

"Well, I was convinced. My mind was a 'leaky pail.' I had never been able to remember a man's name thirty seconds after I'd been introduced to him, and as you know, I was always forgetting things that ought to be done. I had recognized it as a fault, but never thought of it as a definite barrier to business success. I started in at once to make my memory efficient, taking up a memory training course which claimed to improve a man's memory in one evening. What you call my good fortune to-day I attribute solely to my exchanging a 'leaky pail' for a mind that retains the things I want to remember."

Powers' story set me thinking. What kind of a memory did I have? It was much the same as that of other people I supposed. I had never worried about my memory one way or another, but it had always seemed to me that I remembered important things pretty well. Certainly it never occurred to me that it was possible or even desirable to improve it, as I assumed that a good memory was a sort of natural gift. Like most of us, when I wanted to remember something particularly I wrote it down on a memorandum pad or in a pocket notebook. Even then I would sometimes forget to look at my reminder. I had been embarrassed—as who has not been?—by being obliged to ask some man whom I had previously met what his name was, after vainly groping through my mind for it, so as to be able to introduce him to others. And I had had my name requested apologetically, for the same purpose, so that I knew I was no different than most men in that way.

I began to observe myself more closely in my daily work. The frequency with which I had to refer to records or business papers concerning things that at some previous time had come under my particular notice amazed me. The men around me who were doing about the same work as myself were no different than I in this regard. And this thought gave new significance to the fact that I had been performing practically the same subordinate duties at exactly the same salary for some three years. I couldn't dodge the fact that my mind, as well as most other people's, literally limped along on crutches, because it could not retain names, faces, facts, and figures. Could I expect to progress if even a small proportion of the important things I learned from day to day slipped away from me? The only value of most of my hard-won experience was being canceled—obliterated—by my constantly forgetting things that my experience had taught me.

The whole thing hit me pretty hard. I began to think about the subject from all angles as it affected our business. I realized that probably hundreds of sales had been lost because the salesman forgot some selling point that would have closed the order. Many of our men whom I had heard try to present a new idea or plan had failed to put over their message or to make a good impression because they had been unable to remember just what they wanted to say. Many decisions involving thousands of dollars had been made unwisely because the man responsible didn't remember all the facts bearing on the situation and thus used poor judgment. I know now that there isn't a day but what the average business man forgets to do from one to a dozen things that would have increased his profits. There are no greater words in the English language, descriptive of business inefficiency than the two little words "I forgot."

I had reached my decision. On the recommendation of Powers, I got in touch at once with the Independent Corporation which shortly before had published the David M. Roth Method of Memory Training. And then came the surprise of my life. In the very first lesson of the course I found the key to a good memory. Within thirty minutes after I had opened the book the secret that I had been in need of all my life was mine. Mr. Roth has boiled down the principles perfecting the memory so that the method can almost be grasped at a glance. And the farther you follow the method the more accurate and reliable your memory becomes. Within an hour I found that I could easily memorize a list of 100 words and call them off backward and forward without a mistake. I was thunderstruck with the ease of it all. Instead of study the whole thing seemed like a fascinating game. I discovered that the art of remembering had been reduced by Mr. Roth to the simplest method imaginable—it required almost nothing but to read the lessons! Every one of those seven simple lessons gave me new powers of memory, and I enjoyed the course so much that I look back on it now as a distinct pleasure.

The rest of my story is not an unusual one among American business men who have realized the value of a reliable trained memory. My income today is close to $30,000. It will reach that figure at the beginning of our next fiscal year. And two years ago I scarcely made what I now think of as a decent living.

In my progress I have found my improved memory to be priceless. Every experience, every business decision, every important name and face is easily and definitely recorded in my mind, and each remembered experience was of immense value in my rapid strides from one post to another. Of course, I can never be thankful enough that I mended that "leaky pail" and discovered the enormous possibilities of a really good memory."

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Mr. Roth's fee for personal instruction to classes limited to fifty members is $1,000. But in order to secure nation-wide distribution for the Roth Memory Course in a single season the publishers have put the price at only five dollars, a lower figure than any course of its kind has ever been sold before, and it contains the very same material in permanent form as is given in the personal $1,000 course.

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Electrical Experimenter

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Vol. VI. Whole No. 71 MARCH, 1919 Number 11

33 Assembled Locomotives on One Ship

The Enterprise of American War Engineering Which Enabled Thirty-Three Assembled Locomotives to be Delivered 'Cross Seas in a Single Ship, for Immediate Duty at the Front.

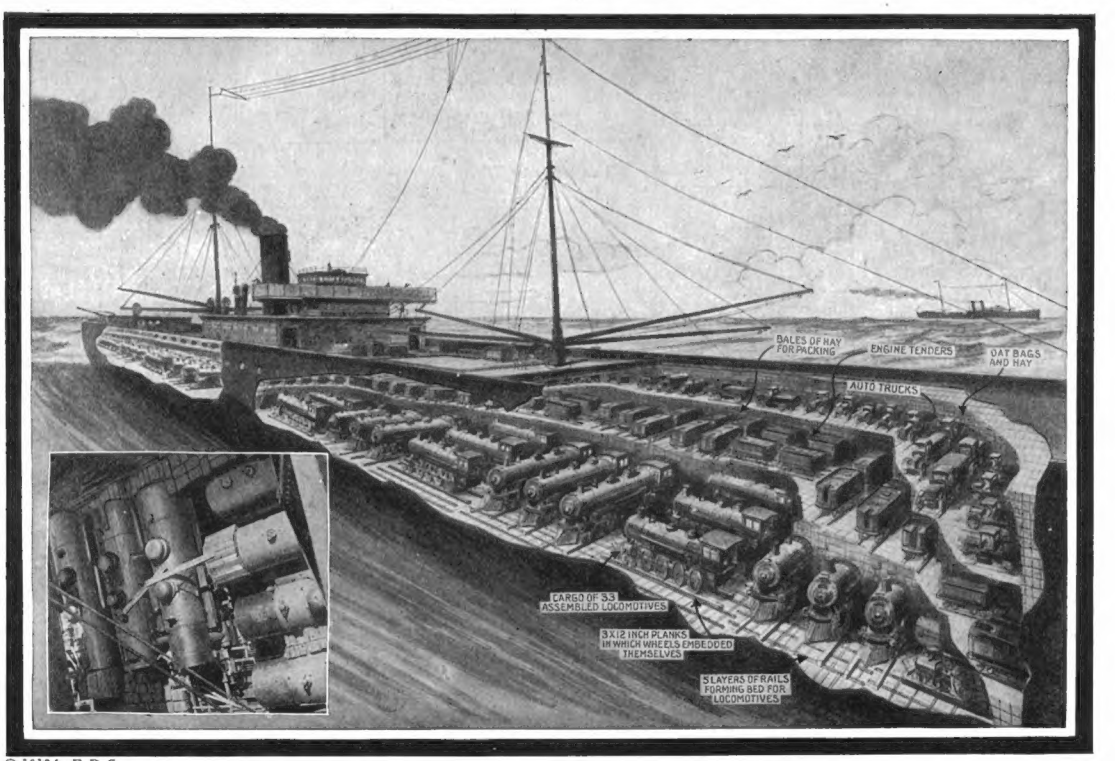
EVER persevering American ingenuity and the knowledge that "over there" thousands of our boys were depending on us folks back home, to keep our shoulders to the wheel, makes records of the seemingly impossible deeds actually accomplisht, read like the magic of Aladdin's Lamp.

As a specific instance, let us look at the railroad situation in France when General Pershing arrived on the scene of action with the first vanguard of American troops. French Atlantic ports were nearly 270 miles from the fighting front. It was one problem to get supplies across seas infested with mines and submarines, and still a greater task to move this material with all possible haste to the points where it would be most needed. It is well known that the French railroad system had collapst; all it could do was to care for the French army, and to move the thousands of tons of material necessary for the successful campaigning of Pershing's army behind a few creeping French locomotives left at our disposal was well nigh impossible.

General Pershing saw the immediate need for American railroad equipment and one of his first cables home was for the urgent delivery of locomotives, cars and rails. He made the War Department see the need of providing these facilities so that the American effort in the Great Cause would not be a failure. And so it was that Army officials undertook the buying and shipping of locomotives. The first locomotives sent were in great big bulky cases—*knocked down*. As yet they did not dream of sending them *completely assembled*.

Once these parts reached France they were put in the hands of a dozen or more

(*Continued on page* 810)


BALES OF HAY FOR PACKING
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AUTO TRUCKS
CARGO OF 33 ASSEMBLED LOCOMOTIVES
3 X 12 INCH PLANKS IN WHICH WHEELS EMBEDDED THEMSELVES
5 LAYERS OF RAILS FORMING BED FOR LOCOMOTIVES

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In the Early Months of America's Participation in the World War, Locomotives Were Shipt Overseas in Parts. In Consequence a Vast Amount of Valuable Time Was Lost in Dismounting and Reassembling the Parts. Later the Scheme Was Evolved of Loading the Locomotives Intact, as Here Shown, Thirty-three of Them Having Been Sent Over in One Vessel. Insert View Shows Scene Looking Down in Hold. Note Bales of Hay.

Five Conversations Over One Wire

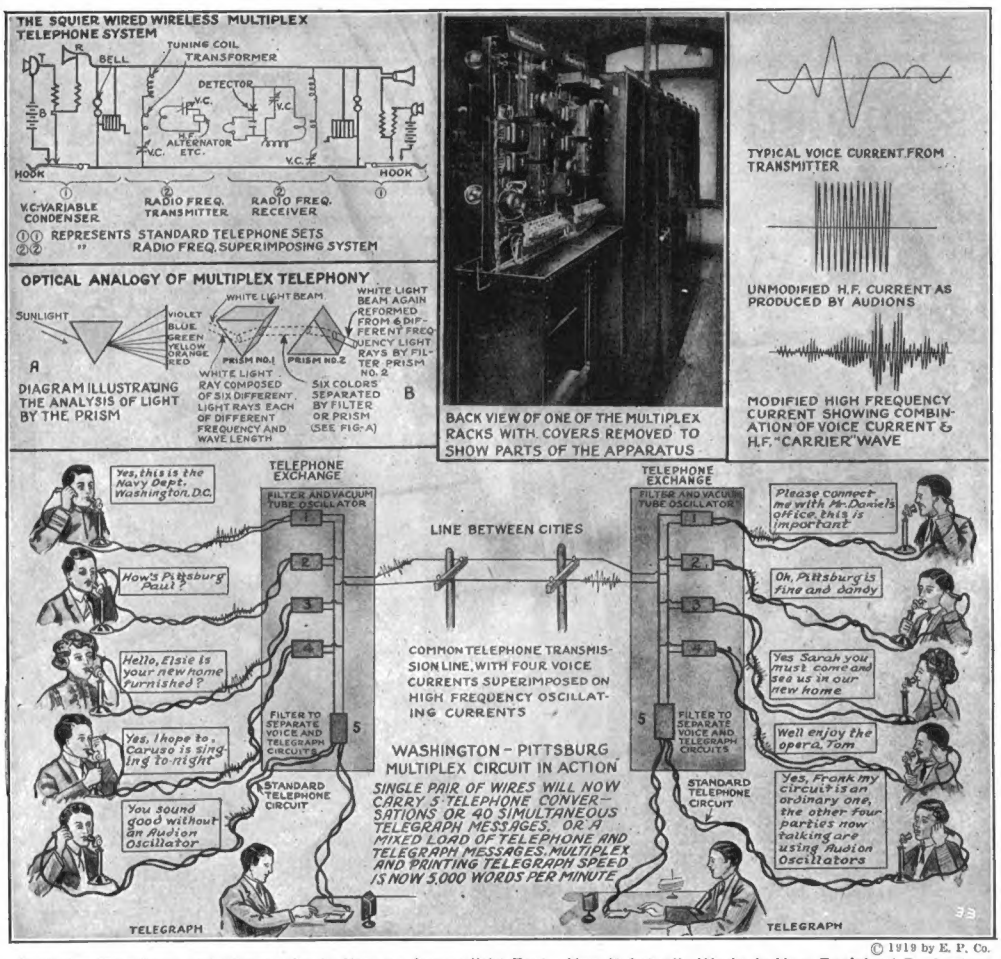
Multiplex Telephony and How It Works

THE story of the development of the multiplex telephone and telegraph system reads like that of many other inventions. It is a story of long years of effort to accomplish a great result. The steam turbine, for example, is but recently developed to be practically useful and yet was suggested in principle as long ago as 130 B. C. Dr. Alexander Graham Bell was experimenting science of telephony since that science was born in a Boston attic in 1875. Its possibilities lie in the direction of expansion of long distance service. Physically it can be employed on any open wire telephone line, but practically it is not advantageous to use it on any short line, say less than 100 miles in length. The highly technical equipment required is so costly that it is economically available only for long lines. There is at now it has been carrying messages, which come to Baltimore from Washington over the ordinary circuits and these are given to the multiplex for transmission to their destination.

For some years past the Bell System engineers have sought to make it possible for anyone to talk to anyone else in any other part of the country at any time. The phantom circuit, which utilizes wires in two ordinary circuits to provide a *third* conductor of speech, was a great step toward this goal, greatly expanding the service possibilities of existing long lines. Then came *transcontinental telephony*, making a real neighborhood of the Nation. Now, with the multiplex system, the engineers greatly enlarge the service capacity of all long lines which economically may be equipt with the system. The three transcontinental circuits, for example, two of which are of wire while one is a phantom circuit, when equipt with the multiplex system can carry 10 telephone conversations at once, instead of 3 as at present.

The new system sends five voice currents *simultaneously* over *one* telephone circuit of two wires, taking each current as it is delivered into an ordinary telephone and delivering it at its destination, thru another ordinary telephone, exactly as it was formed at the sending point. These five voice currents travel together and are sorted for delivery at their destination. Not a tone or inflection of the speaking voice is changed in passage. This result is achieved by combining each voice wave with a high-frequency inaudible *carrier current* which has characteristics in degrees of frequency that are entirely different from those of other carrier currents. See the various forms of the voice and carrier currents shown herewith. The carrier current

(*Continued on page* 826)


THE SQUIER WIRED WIRELESS MULTIPLEX TELEPHONE SYSTEM
TUNING COIL
TRANSFORMER
BELL
DETECTOR
V.C.
H.F. ALTERNATOR ETC.
HOOK
V.C.-VARIABLE CONDENSER
RADIO FREQ. TRANSMITTER
RADIO FREQ. RECEIVER
REPRESENTS STANDARD TELEPHONE SETS
RADIO FREQ. SUPERIMPOSING SYSTEM
OPTICAL ANALOGY OF MULTIPLEX TELEPHONY
SUNLIGHT
VIOLET BLUE GREEN YELLOW ORANGE RED
WHITE LIGHT BEAM
PRISM NO.1
WHITE LIGHT RAY COMPOSED OF SIX DIFFERENT LIGHT RAYS EACH OF DIFFERENT FREQUENCY AND WAVE LENGTH
PRISM NO.2
WHITE LIGHT BEAM AGAIN REFORMED FROM 6 DIFFERENT FREQUENCY LIGHT RAYS BY FILTER PRISM NO. 2
SIX COLORS SEPARATED BY FILTER OR PRISM (SEE FIG. A)
A
B
DIAGRAM ILLUSTRATING THE ANALYSIS OF LIGHT BY THE PRISM
BACK VIEW OF ONE OF THE MULTIPLEX RACKS WITH COVERS REMOVED TO SHOW PARTS OF THE APPARATUS
TYPICAL VOICE CURRENT FROM TRANSMITTER
UNMODIFIED H.F. CURRENT AS PRODUCED BY AUDIONS
MODIFIED HIGH FREQUENCY CURRENT SHOWING COMBINATION OF VOICE CURRENT & H.F. "CARRIER" WAVE
TELEPHONE EXCHANGE
FILTER AND VACUUM TUBE OSCILLATOR
LINE BETWEEN CITIES
TELEPHONE EXCHANGE
FILTER AND VACUUM TUBE OSCILLATOR
Yes, this is the Navy Dept. Washington, D.C.
How's Pittsburg Paul?
Hello, Elsie is your new home furnished?
Yes, I hope to. Caruso is singing to-night
You sound good without an Audion Oscillator
Please connect me with Mr. Daniel's office, this is important
Oh, Pittsburg is fine and dandy
Yes Sarah you must come and see us in our new home
Well enjoy the opera, Tom
Yes, Frank my circuit is an ordinary one, the other four parties now talking are using Audion Oscillators
FILTER TO SEPARATE VOICE AND TELEGRAPH CIRCUITS
STANDARD TELEPHONE CIRCUIT
COMMON TELEPHONE TRANSMISSION LINE, WITH FOUR VOICE CURRENTS SUPERIMPOSED ON HIGH FREQUENCY OSCILLATING CURRENTS
WASHINGTON – PITTSBURG MULTIPLEX CIRCUIT IN ACTION
SINGLE PAIR OF WIRES WILL NOW CARRY 5 TELEPHONE CONVERSATIONS OR 40 SIMULTANEOUS TELEGRAPH MESSAGES, OR A MIXED LOAD OF TELEPHONE AND TELEGRAPH MESSAGES. MULTIPLEX AND PRINTING TELEGRAPH SPEED IS NOW 5,000 WORDS PER MINUTE
TELEGRAPH
TELEGRAPH

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Multiplex Telephony and Telegraphy Is Now an Accomplisht Fact. How It Actually Works Is Here Explained By Analogy and Picture Diagrams. Five Telephone Conversations Can Be Carried On Over One Pair of Telephone Wires, While Telegraph Messages Fly Over the Circuit In Either Direction Simultaneously.

to produce a multiplex telegraph in 1872 and three years later, while still working on that device, he conceived of the telephone —stated Mr. Bancroft Gherardi, acting chief engineer of the American Telephone and Telegraph Company.

Now, 46 years after Dr. Bell made these experiments, the *multiplex telephone and telegraph system* has become a reality. The system is the product of no one man's efforts, but rather the result of the cumulative efforts of several hundred members of the Bell Telephone System's engineering staff, covering a period of years. It is one of the greatest single contributions to the present but one installation in service, that on the Baltimore-Pittsburgh line used in the recent demonstrations. But for the great amount of war work that has engaged our attention, the system would have been demonstrated sooner, and it happened that the need for more circuits to handle the traffic between Washington and the war-work center, Pittsburgh, determined the selection of the place to make the demonstrations. There were sufficient wires from Washington to Baltimore, but not enough from Baltimore to Pittsburg. The multiplex system, therefore, was installed at Baltimore and for several months

The Latest Style in Flashlights

A POCKET flashlight with its small one-half or one-candle-power tungsten bulb operated by a small dry-battery, has practically become a household article the world over. Flashlights are today manufactured by the million, while more millions of people are daily clamoring for them. Tens of millions of flashlights were in constant use during the progress of war-time activities in Europe, and what a great boon it has been to the soldier can well be imagined. The accompanying illustrations show a number of extremely useful and not always well-known applications of the pocket flashlight which will prove of practical use on many occasions.

One of the latest and ingenious arrangements for utilizing a flashlight is that shown at Fig. 1, which comprises an *illuminated note-pad* for use at night or in dark places. The use of this illuminated note-pad will prove very extensive undoubtedly, and for one thing it may often prove of assistance in taking notes at lectures, not to mention a very wide application in the Army and Navy. The illumination is so arranged that no noticeable glow is seen, but simply the illuminated square opening over which the paper roll slides. A second paper roll is included, so that a carbon copy can be kept for record. The case when closed resembles a kodak.

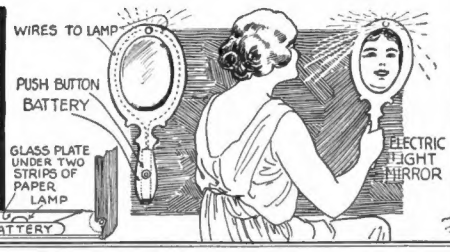
Figure two shows a self-contained *electric light mirror*, invented by Mr. H. Gernsback several years ago. This unique mirror has a small flashlight battery placed in the hollow handle. On the front of the handle a push-button is placed and the wires to the lamp at the top of the mirror frame are secreted within it.

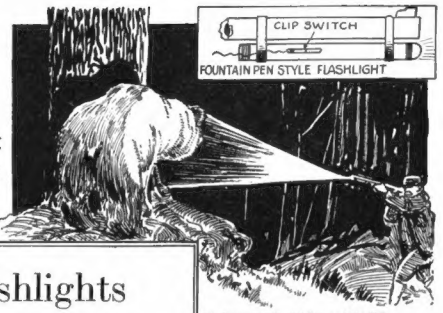
Figure three shows the *gun-light* which has been quite extensively exploited, and while we have never had the opportunity of trying out a fountain-pen flashlight or a larger model flashlight attached to a rifle, we have seen the pistol flashlight used, and it proves one of the most deadly combinations imaginable. All the marksman has to do is to move the pistol about until the target lies in the center of the subtended flashlight zone and then pull the trigger. It should prove a fine thing for hunting down burglars, rats, cats, and what not.

A recently patented eye-diagnostic lamp, known as a *retinoscope* is illustrated in Fig. 4. This comprises a very compact and efficient electric lamp and mirror, as well as sighting device for the use of opticians in examining the eye. The flashlight battery is contained in the handle of this efficient instrument, and the bulb of the flashlight projects a beam of light on to the small mirror, which is set at an angle of 45 degrees. Thru the center of this mirror there is a small hole which is in line with a sighting tube at the rear of the mirror frame. It is used in the manner illustrated.

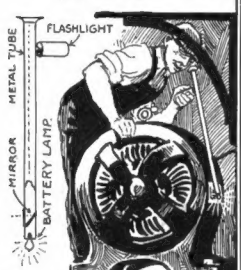
The well-known flashlight combination, known as the *shave light*, is shown at Fig. 5. Several varieties of this handy device are on the market and it has proved a blessing indeed to thousands of soldiers—officers and dough-boys alike—who have often had to shave in dingy or pitch dark dug-outs and other places of shelter on the battlefield. In the shave-light device illustrated by Fig. 5, the flashlight battery is connected by means of a small flexible twin-conductor with a lamp bulb placed over the mirror.

One of the latest and most practical every-day uses of the flashlight is in meter-reading. See Fig. 6. The usual application of the flashlight in this field involves the carrying of an ordinary tubular flashlight by the meter reader, but the illustration herewith shows one of the newer developments in the form of a *flashlight meter camera*. With this clever device it is only necessary to place the camera before the meter to be read, the button is prest, several flashlight bulbs connected in multiple throw a strong light on the meter dials, the camera-shutter clicks simultaneously, and (*Continued on page* 821)

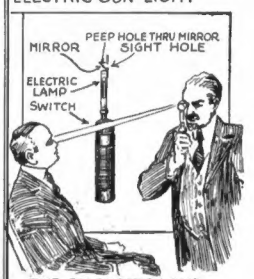




ELECTRIC GUN LIGHT



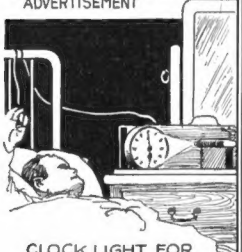
THE FLASHLIGHT INSPECTOSCOPE



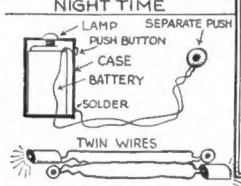
EYE DIAGNOSTIC LAMP

ELECTRIC HAT & SHIRT FRONT ADVERTISEMENT

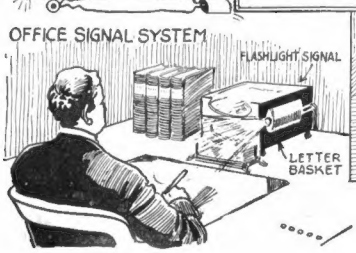
THE SHAVELIGHT FOR SOLDIERS AND CAMPERS

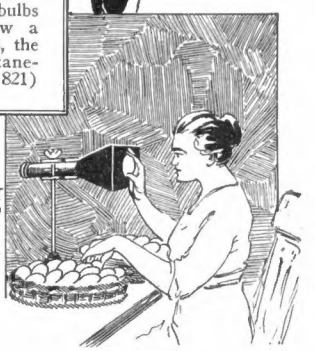


CLOCK LIGHT FOR NIGHT TIME



THE FLASHLIGHT METER CAMERA





"The Border Wireless" and "The Hun Within"

STEVE RANSOM (William S. Hart), a typical Westerner, who has been reared on a ranch in Wyoming, which was wrested from his parents by a railroad company, becomes embittered and revengeful, and taking the law into his own hands, develops into a bandit, committing several daring robberies at stations belonging to the railroad company which had despoiled him and brought his aged parents to death. He eventually becomes a fugitive with a price upon his head and drifts to Yellow Dog, Arizona, near the Mexican border.

Elsa Miller is a telegraph operator at Yellow Dog, and the guardian of her younger brother, Carl. Elsa is on her way to deliver a message to Herman Brandt at the Magdelena Mines and is attacked by Mexican bandits. Steve rescues and falls in love with her and decides to remain at Yellow Dog. Frederick Brandt loves Elsa, but she is unaware that the Magdelena Mines have been converted into the headquarters for German spies with a cleverly concealed wireless apparatus by which messages are transmitted to Mexico and from there to Honduras and then to Berlin. Brandt is in direct communication with Von Helm, head of the German Secret Service in New York City.

Steve becomes suspicious of Brandt, when he and his assistant, Frederick Schloss, express contempt for the American flag and the fighting abilities of the United States. Steve forces Brandt to kiss the American flag. War with Germany is declared, and Steve determines to enlist. He calls on Elsa, determined to reveal his past life to her, and invites her to ride part of the way with him to Fort Scott; she plainly evinces her love for Steve. During their absence Steve's shack is ransacked by Brandt and Schloss; photographs of Steve's father with an inscription on the back, reveals the fact that Steve's real name is Ransom, and not Allen—which name he assumed while in Yellow Dog. Brandt sends a telegram to the Sheriff at Willow Springs, asking for information regarding Steve and thus learns that Steve is a fugitive from justice. Carl reveals the fact that Steve is on his way to Fort Scott to enlist, and Brandt forces the boy to telegraph the commanding officer at Fort Scott the facts he has discovered regarding Steve.

While awaiting examination at Fort Scott, Steve overhears the conversation between the commanding officer and the telegraph operator, and makes his escape through a window. He is pursued by the soldiers but eludes them and takes refuge in a wooded canyon. Elsa learns of the occurrence, but this does not shake her faith in him. A day or two later, a code message comes for Brandt, and Carl starts with it for the Magdelena Mines. He is thrown from his horse and is lying unconscious, when Brandt and Schloss and another spy ride by. They go thru his clothes and find the message, which is translated with the aid of a code book. Carl, who has regained consciousness, overhears the translation of the message, the purport of which is that General Pershing is on his way to Europe and the Germans are planning to sink the vessel on which he has sailed. The two men take their departure, leaving their man to watch Carl.

Elsa now appears and Carl whispers to her the nature of the message. The German, hiding behind the bushes, overhears Carl and is about to shoot him, when Steve, who has been hiding in the bushes all the time and witnest the entire proceeding, kills the German. Carl is moved to a comfortable position, and Steve and Elsa ride to the Mine to prevent the sending of the message, which would mean the death of General Pershing, surprise the Germans, and after a fierce battle, take possession of the *wireless apparatus* and succeed in sending out a call for help to Fort Scott, after which they destroy the wireless. The soldiers arrive and make the Germans their prisoners. The charge against Steve is dismist and the story ends happily with Steve and Elsa watching the soldiers lined up for the sundown dress parade.

Top Left:—Doing the Kaiser's Dirty Work. A Scene from "The Hun Within," a Paramount-Artcraft Feature Film Drama.

Top Right:—The Secret Service Hun Seems to Be More Or Less Excited In This Scene from "The Hun Within." Note the Elaborate Wireless Receiving Set Used In This Recent Screen Play. Reality Is the Keynote In the Photo Dramas of To-day. Once a Soap Box, Fitted With a Few Dozen Binding Posts and Some Magnet Coils, Was Good Enough for a "Prop", But the Film Fans Nowadays Are a Wise Lot. Besides, There May Be a Radio Amateur In the House, and Oh! Boy! If There Is Anybody That Can Outdo Him In "Roasting" a Fake Wireless Or Electrical "Prop"—Well, We Have Failed to Meet Him. He Can Tell By the Color of the Villian's Eye Whether He Is Receiving Actual Dots and Dashes, Or Only Imagining It. And His Hands—Every False Move Is a Heart-Stab to the Radio-Bug. Lower View:—In This Scene from "The Border Wireless," an Artcraft Feature Screen Play, "Big Bill Hart" Gives the Hun Wireless Operator a Small Installment of What Is Coming to Him While Pretty Wanda Hawley, Who Can Actually Send Legible "Morse," Cancels the Wireless Message That Has Just Gone Out.

IN a large city near New York lives Henry Wagner, a German-American who left Germany years previously be-

(*Continued on page 823*)

Gold and Silver Located With Sound Waves

MOST probably you will remember having read some of those entrancing fairly tales in your younger days, wherein a person happened to be gifted with such transcendental intellectual powers, that he could for example stamp his foot on the ground or simply make a certain sound when the location of gold or silver would immediately be made known to him. Of course this all sounds like "Bul-garia" to us nowadays, but thanks to a twentieth century magician, Prof. R. A. Fessenden, the brilliant American inventor and scientist, it has become possible to do this identical thing, i.e., to project a sound wave, and by measuring its reflection and deflection scientifically by means of suitable detecting and recording instruments, to locate exactly the position of underground ore bodies, no matter what the ore may be, whether gold, silver, lead, zinc, copper, etc.

As Prof. Fessenden points out in his patent on this scheme of locating ore bodies, his invention provides methods and apparatus whereby, being given or having ascertained two or more of the following quantities, i. e., the time, distance, intensity and medium, one or more of the remaining quantities may be determined. For example, being given the distance between two points in a mine, and having determined the time required by a sound wave to travel between the two points, it is then possible to draw calculations in regard to the probable nature of the rock between the two points; also, if an echo be observed or a refraction of the sound, it is possible to estimate the distance of the reflecting or refracting vein. Hence this new apparatus is intended for the location of hidden ore bodies by means of measurements made on the velocity, direction, reflection, refraction, absorption and other phenomena of sound waves transmitted thru the medium containing the ore bodies, which is invariably, of course, the earth. The inventor claims that by this means he has been able in a certain test to determine the location accurately of a body of mineral, invisible to the eye, at a distance of two and one-half miles, and further, this test was witnest and verified by a number of skilled engineers.

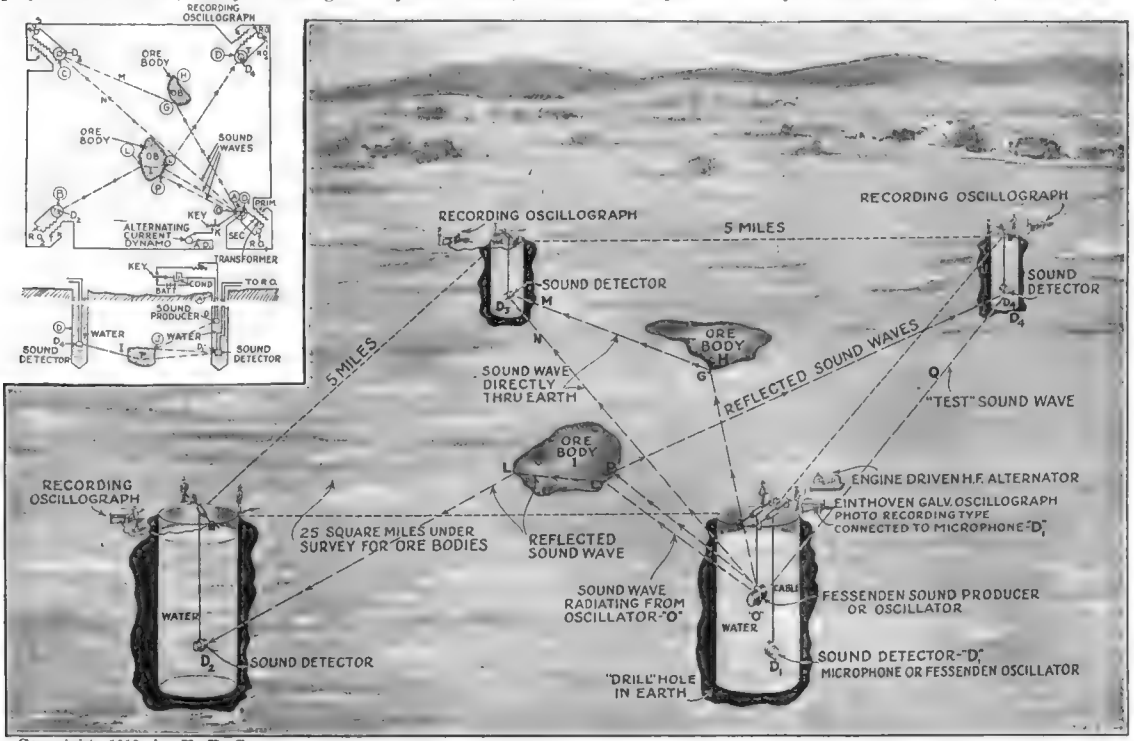
In starting to survey a piece of ground by this method, in which ore deposits are suspected, a space may be laid off about five miles square, as the accompanying illustration shows. This gives an area of twenty-five square miles under survey. At each corner of this square there are driven four drill holes, A, B, C, D, which are filled with water. Toward the bottom of these water filled holes there are placed sensitive sound detectors, such as microphones or small Fessenden oscillators, D_1, D_2, D_3 and D_4. These sound receiving devices are connected to the secondaries of transformers as indicated, and to oscillographs of the photographic recording type. These oscillographs employ the quartz-fiber Einthoven galvanometers. In one of the wells there is placed a powerful sound producing apparatus, O, preferably of the Fessenden oscillator type also. This is connected thru its leads, with the primaries of the transformers in the oscillograph circuits and to the alternating current dynamo, A—D, whenever the key K is deprest. Hidden ore bodies are indicated at the points H and I.

The oscillograph recording apparatus is so adjusted that when the sound-producing oscillator key, K, is deprest, a moderately strong indication is produced on the photographic records of the oscillographs, R—O, which fixes on the photographic records the exact instant at which the key is deprest. Simultaneously a sound wave is emitted from the oscillator, O, which after being reflected as at G by the ore body H, or reflected back as from J, Fig. 2, by the body I, or reflected as from P by the ore body I, or refracted as at LL, or possibly proceeding directly thru the earth as shown by the dotted lines M—N, reaches the indicators or microphones, D_3, D_4, D_2 and D_1 and is recorded on the oscillographs R—O's, 3, 4, 2 and 1.

Instead of using the alternator to produce the sound at the oscillator, O, a condenser discharge may be employed to actuate a sounder, the condenser key on being deprest charging the condenser from a battery, and on the key being released and coming against a second contact, it discharges the condenser thru the sound producing mechanism. The patent describes this auxiliary sound producing mechanism.

Since the oscillograph photographic strip moves along thru the machine with a regular and known velocity, the distance on the strips between the records produced thru the transformers whenever the key, K, is deprest, and the records made by the sound waves received, whether direct or by reflection, refraction or echo, will indicate the distance between the drill and holes and

(*Continued on page* 828)



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Now We'll All Be Rich, Thanks to Prof. Reginald A. Fessenden, the Eminent American Scientist, Who Here Tells Us How to Positively and Accurately Locate Metallic Ore Deposits in the Earth. The Principle Involves the Measuring of the Sound Velocity Between Various Points and the Determination of the Direction from Which It Is Refracted in Each Case.

Sorting Tobacco Leaves by Electricity

By GEORGE HOLMES

MANY ingenious machines and devices have been invented and are widely used in the manufacture of tobacco products and all modernly equipt cigar and cigarette factories bristle with machinery. The more striking is the fact that the tobacco growers and planters have been much neglected by the genius of inventors. Thus we see that tobacco is grown today with the same primitive methods as it was 100 years ago.

The inventive spirit of our progressive age, which benevolently gave a helpful lift to almost every trade and industry and handed so many labor-saving appliances to agriculture, past in silence the extensive tobacco plantations of America and the world.

Upon the initiative of one of the biggest tobacco growers in the world, a New York inventor and engineer, Mr. H. Hartman, took up the problem several years ago of tobacco planting and handling right at the farms. And what he saw there set him to thinking. He soon noticed that one of the most costly operations at a tobacco plantation is the *sorting of leaves by their different length.* Every leaf is taken by hand at both ends and measured and placed according to its length into a different box.

So-called sun-grown tobacco is usually sorted or "sized" by two inches, while shade-grown tobacco, which is used for wrappers, is "sized" partly by inches and partly by two inches. This work is done after the leaves have past thru the "curing" process and are brown, soft and pliable.

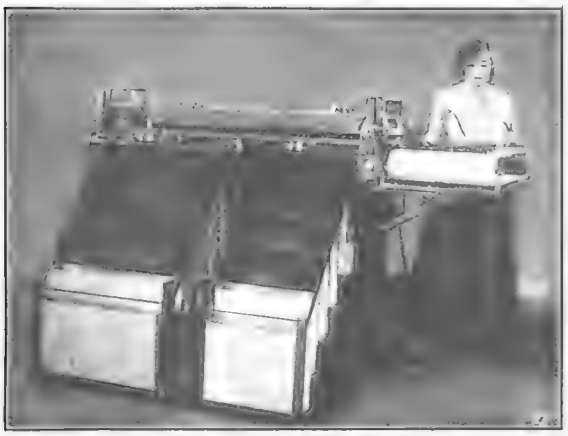
Now anyone can easily imagine the tremendous amount of manual labor involved in measuring each single leaf of the many millions grown on an average tobacco farm. But the tobacco can not be sold if not sorted into different lengths.

After many experiments with three gradually more and more improved machines, which Mr. Hartman constructed at his workshop and laboratory, he finally succeeded, and the semi-electric "Leaf Tobacco Sizing and Sorting Machine", illustrated here is the result. This machine also marks as a milestone the opening of tobacco growing to mechanical development.

In this machine, which is also shown diagramatically, the tobacco leaves are simply placed upon a feeding belt by an operator in front of the machine. This belt brings the leaves below two curved clamp openers which always open two pairs of clamps, carried by two endless roller chains moving under 90° horizontally to the feeding belt over a distribution table or bench. The clamps, after having been opened during motion by said curved openers, grip the leaves at their stem and pull them over the table and thru a pair of resilient contact rollers, which stand vertically in the path of the motion of the clamps. As long as a leaf is between the contact rollers, a metallic electric contact between the latter is prevented, but a low voltage circuit will be closed thru them the moment the tip of the leaf passes out. As the contact rollers are co-operating with a series of contact segments arranged at the centre line along the bench, one of these segments will be swept by a contact brush from the clamp in circuit with the rollers. An electric current will then pass thru the rollers, said particular segment and one of a number of solenoids will attract its armature and thus open one of the covers, which can be seen arranged under an incline at both sides of the machine.

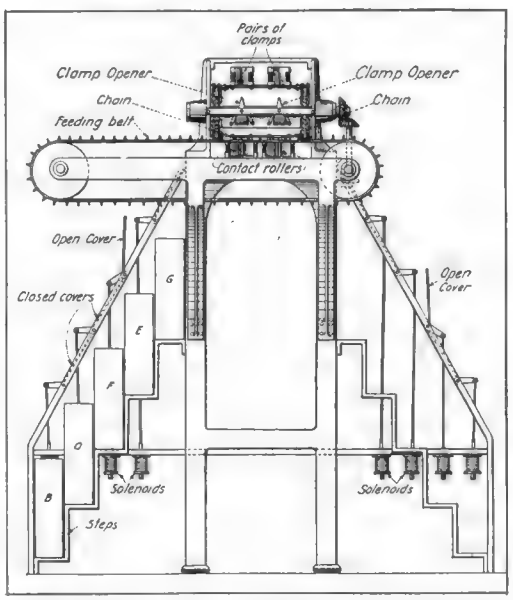
At the same time an electro-magnetic stop will emerge from the flat table and, being in the centre line with the clamps, will force the latter to open, and to drop the leaf upon the table, from where it will be blown the next moment by comprest air over the edge of the table and slide by gravity downward to fall into the box arranged below the open cover. According to the length of a leaf, a certain contact segment on the table will be in circuit with the contact rollers only at the moment said leaf passes entirely thru the rollers, and only that particular cover connected with said segment will open, as intermediary relays will at the same moment interrupt for a predetermined time the connection between all following segments and their respective solenoids. There are as many segments and solenoids as there are different covers. The first section, having five boxes, will receive the five shortest leaves. If a leaf is longer, no segment will come into contact in said first section, the electro-magnetic stop will not appear and the clamp will carry that leaf into the second section where the same process will be repeated. The second section provided with five boxes of longer dimensions, is an exact

(*Continued on page* 810)



The Latest Device in the Tobacco Industry Is This Electric Leaf Sorter. It Sizes the Leaves as They Pass Along and Deposits Them in the Corresponding Compartments Below.

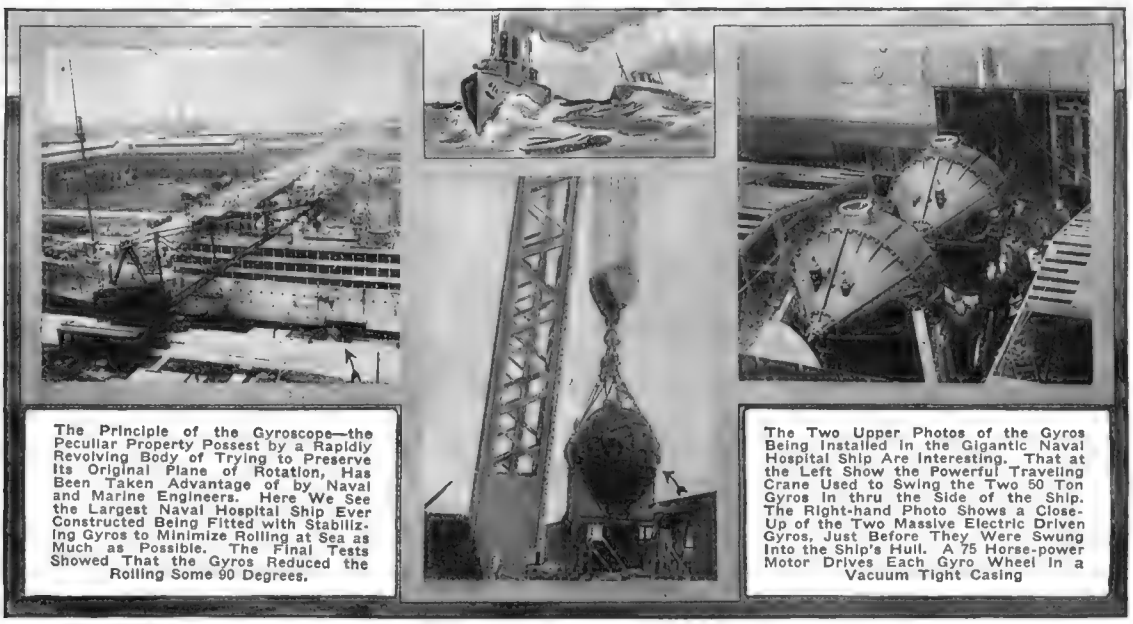
Another View of the Electric Tobacco Leaf Sorting Machine. Two Leaves Can Be Seen Sliding Down Toward the Open Compartments. The Inventor Is Seen Operating the Machine.



End-wise Sectional View of the Tobacco Leaf Sorting Machine. The Receptacle Doors Are Opened by Solenoids Controlled by the Sizing Mechanism at the Top of the Machine.

Hospital Ship Fitted with Gyroscopic Stabilizer

PERHAPS you are familiar with the mechanical device known as a "gyroscope", which possesses remarkable self-centering or stabilizing properties. The Sperry airplane stabilizer, as well as the non-rolling ship stabilizer, utilizes this clever device. It involves the simple phenomenon that if you take a heavy steel or other wheel and spin it at high speed, then the spinning wheel and its attached frame will tend to preserve the same plane of rotation. This is daily demonstrated by the ordinary bicycle. Hold the bicycle clear of the ground and have someone turn the pedals rapidly. Now try to turn the bicycle sidewise while the wheels are rotating at high speed. You will find it very difficult—all because of the law above stated. Thus the naval engineers have discovered that by placing one or more powerful gyros in a ship, that the ship will not roll to any appreciable extent in a heavy sea. Hospital and war-ships are therefore being fitted with giant electric driven gyros for the purpose of keeping them on a more even keel in stormy weather. The improvement in gunnery from warships so equipt and stabilized is readily apparent.



The Principle of the Gyroscope—the Peculiar Property Possest by a Rapidly Revolving Body of Trying to Preserve Its Original Plane of Rotation, Has Been Taken Advantage of by Naval and Marine Engineers. Here We See the Largest Naval Hospital Ship Ever Constructed Being Fitted with Stabilizing Gyros to Minimize Rolling at Sea as Much as Possible. The Final Tests Showed That the Gyros Reduced the Rolling Some 90 Degrees.

The Two Upper Photos of the Gyros Being Installed in the Gigantic Naval Hospital Ship Are Interesting. That at the Left Show the Powerful Traveling Crane Used to Swing the Two 50 Ton Gyros In thru the Side of the Ship. The Right-hand Photo Shows a Close-Up of the Two Massive Electric Driven Gyros, Just Before They Were Swung Into the Ship's Hull. A 75 Horse-power Motor Drives Each Gyro Wheel In a Vacuum Tight Casing

One of the accompanying photos shows Gyro unit No. 2 of the twin set just being transferred by a hundred-ton S-leg crane. A second photo shows a close-up of the two Gyro units, while the third photo shows the relative size of the Gyros with the ship and also the massive traveling crane used to swing them into the ship.

These Gyros were installed in a Naval Hospital ship so that the wounded on board would be subject to the least amount of rolling, that to the present time is very apparent on all ships, especially in bad weather. The final stabilizing test with the Gyros was found to reduce the rolling some 90 degrees, so it can be readily seen that they do help some.

The combined weight of the unit was 100 tons and the ship was the largest hospital ship ever constructed. The weight of the two gyro wheels is 25 tons each. The weight of the two casings is 25 tons each. The diameter of the gyro wheels is 9 feet, and of the casings 12 feet. The bearings used are standard roller type and self-aligning, fitted to 12-inch shafts. The power used to drive the gyro wheel is a 75 H.P. A. C. electric motor in each. The casing was made absolutely vacuum tight and the gyros run in 30 inches or nearly perfect vacuum. The bearings receive a continuous bath of oil, pumped at the rate of 200 gallons a minute, properly screened and cooled. In 35 minutes the gyro attained a speed of 1,100 R.P.M (working speed). A trial speed of 1,600 R.P.M. was attained, the current cut off and the gyros ran for *three and one-half days*, gradually dropping in speed to "Dead".

The side of the ship had to be cut away in order to install the gyros and they were slid into place by means of skids; the time required to slide them into place was 7½ minutes. Besides the 75 H.P. A. C. motor in each gyro, a rotary-converter is used and another 75 H.P. motor is used to *precess* the gyros from left to right to meet the roll of the ship. This last motor is controlled by another sensitive gyro (small and of high speed) located on the ship's bridge.

The two gyros were located amidships below medi-centric height and they ran in opposite directions to each other; that is, the port gyro ran clock-wise and the starboard gyro ran anti-clock-wise, both at the same speed. To reduce the vibration of the gyros to a minimum they were balanced by the plug-method and it took several experts two months to balance them, so perfect must the rotational balance be. Two years were required to complete the gyros and others of larger size are being constructed for super-dreadnought work. These will enable more accurate aim to be had in firing from the ship. Gyros of smaller size are also installed on submarines and destroyers, both classes of installations giving remarkable results.

THE PHOTOELECTRIC SENSITIVITY OF BISMUTHINITE AND VARIOUS OTHER SUBSTANCES.

A recent contribution to the Bureau of Standards scientific papers by Dr. W. W. Coblentz summarizes the results of an investigation of various substances (1) for an increase in electrical conductivity caused by the action of light upon them, and (2) for photoelectric activity when they were charged to a negative potential, in an evacuated chamber, and exposed to light. Pure gallium and silver sulfid were found to have but small photoelectric activity when charged to a negative potential and exposed to light. No change was observed in the electrical conductivity of tellurium, boleite, pyrite, silicon, and mixtures of the sulfids of lead and antimony, when exposed to light. An increase in conductivity was observed in crystals of bismuthinite, cylindrite, molybdenite, selenium, stibnite, boulangerite, jamesonite, and silver sulfid when exposed to light.

Experiments are described in which some of these substances were joined thru a battery to the grid circuit of an audion amplifier and a telephone. The light stimulus was interrupted by means of a rotating sectored disk, as used in Bell's selenium photophone. When using a cell or crystal of selenium the fluctuations in light intensity produced a sufficient change in conductivity to cause a musical note in the telephone. Similarly, in some samples of bismuthinite and of molybdenite, a change in conductivity was produced, which caused an audible sound in the telephone receiver. Further experiments are in progress to determine to what extent and for what wavelengths this is a true photoelectric change (increase) in conductivity, and to what extent it is caused by fluctuations in temperature with a resultant change in resistance within the crystal.

Searchlights of the Deep

Wonderful Fish of the Ocean Depths, That Carry Their Own Lights.

By Dr. E. BADE

IN former years, when the depths of the ocean were still unexplored, it was the common belief that its surface was an uneven monotonous plain, unenlivened by precipices and mountains, hills and valleys. But these ideas have been thoroly repudiated by numerous expeditions sent out to investigate and explore, as far as possible, the conditions existing at the vast bottom of the sea.

The higher parts of the ocean bed, the gentle slopes, the precipices, and the plateaus, which connect the extensive levels of the ocean, are of such an immensity that they can not be compared to anything found on the land. Deep basins of continental extent are interrupted by gigantic marine mountains, while table lands rise from the greatest depth with almost sheer and perpendicular walls.

Only those animals which live near the surface of the ocean and which have ventured within reach of the nets of fishermen, were known in the last century. These nets seldom if ever penetrate more than five hundred feet. But when speaking of the deep sea, a 1,000 foot depth or more is to be considered.

Altho depths of 12,000 feet are common thruout the ocean, a depth of more than 30,000 feet has been reached between two small islands of the Malay Archipelago.

Three hundred feet below the level of the ocean the light is so diffused that it is gloomy, and at a depth of six hundred feet our eye can not detect an infinitesimal ray.

Photographic plates sunk in the Sargasso seas show, at a depth of three hundred feet, all of the different colors of the rainbow; at a depth of 1,500 feet many of the rays can still be found; at a depth of 3,000 feet some of the rays, altho to a much smaller degree, are still present; and at a depth of 6,000 feet no rays can be detected.

A Wonderful Deep Sea Fish Carrying Its Own Electric Light Plant. This Is a Cute Little One by the Name of "Polyipnus Nuttingi Gilbert."

Light does not play such an important rôle in the existence of animal life as it does in the existence of plant life. Plants cannot exist without light. But animal life can and does exist where semi and total darkness prevail. Marine animals living at a depth of 3,000 feet are usually colored black. But those which find their existence just above this dividing line are dark gray to red in color.

But far more wonderful than the absence of light is the fact that animals can withstand the enormous pressure which exists at these depths. It is a simple matter to estimate the pressure exerted by the water at various depths. The weight of a cubic foot of water is equal to the pressure exerted by it. This pressure becomes greater the deeper we go down, and down in the profoundest depths it exerts a pressure of thousands of pounds to the square inch. A result of the pressure is that the tissues of the fish are loosely knit together, and when this enormous pressure is released by bringing these denizens of the deep to the surface, the internal pressure of the body becomes so great that *the fish literally explode.*

Therefore it is no wonder that when the deep sea fish are violently torn from their natural habitat they are invariably in a mutilated condition.

But in these depths of the ocean, where gloom and semi-darkness prevail, the conditions of life are far different from those of the surface waters. The brightly colored algae and sea weeds, the food of many fish, are the children of the sun, while the sinister inhabitants of the profound depths are scavengers, which kill and devour each other.

The faint almost infinitesimal light which penetrates this utter darkness is insufficient to light up the paths of the fish. They do not see their way; they only *feel* their way by means of lateral organs when they come in the vicinity of some boulder or rock. In this darkness we find the most unique and fantastic forms of life—the deep sea fish —which live in perpetual darkness. There, searchlights play thru the watery night, faintly illuminating the vast depths with a cold, death-like glow, a thing man has, as yet, not created.

This wonderful light is produced automatically by the fish. Tiny glands secrete the lighting fluid, reflectors throw it outward, and one or more lenses magnify and control its intensity. (See the illustrations herewith.)

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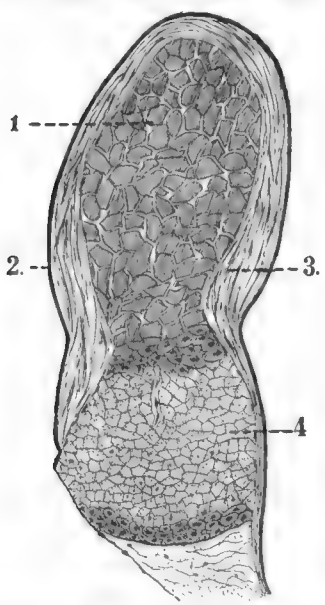
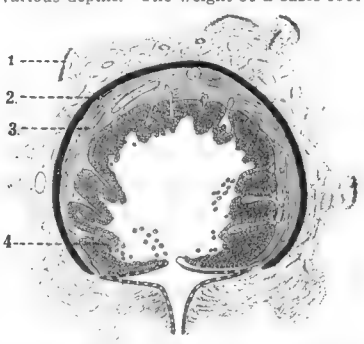
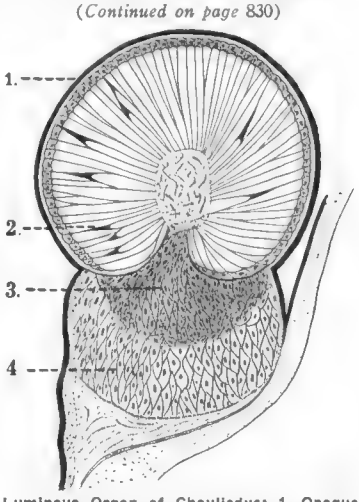


Luminous Organ of Valenciennellus: 1—Glands Which Secrete the Lighting Fluid; 2—Opaque Membrane; 3—Reflector; 4—Lens.



Luminous Organ of Gigantactics: 1—Papillary Feelers; 2—Opaque Membrane; 3—Reflector; 4—Glands Which Secrete the Light.

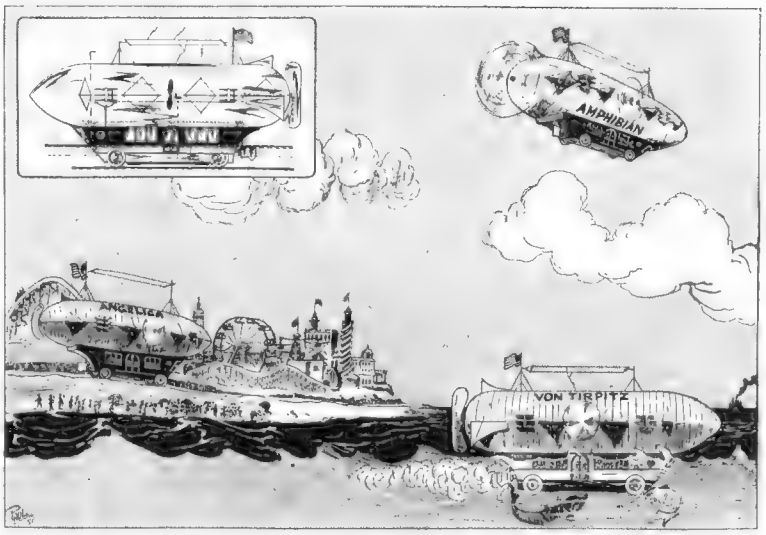


Luminous Organ of Chauliodus: 1—Opaque Membrane; 2—Glands Situated in the Inner Body; 3—Central Part of the Inner Body; 4—Lateral Part of the Inner Body.

THE UPS AND DOWNS OF A THEATER CHAIR.

WE said it, friends, "the ups and downs of a theater chair", and we might add the "downs and ups"—for can you imagine in your wildest moments of philosophical ecstasy what our theaters are going to look like when Mr. Frank Adsit's electrical elevated opera chair is adopted by our theater managers. No, you guest wrong. This is not a phoney patent, but an honest to goodness U. S. patent. Our artist has endeavored to show several of the incidents which might and likely will occur if this invention comes into vogue, and who will gainsay that it will not—for have not forty-eight states—tried and true—gone clean dry without a whimper? This wonderful motor-operated theater chair is also a real boon to the prohibitionist inspector, for all he has to do is push the button and the occupants of the chairs will rise "high and dry'" without a word. Coming down to the real philosophy involved in the design and operation of this newest theater chair, we find that the inventor has provided for causing it to rise and fall whenever a person wishes to pass in front of one of the chairs in order to get to his seat, to one side or the other, by means of three distrinct electromechanical agencies, to wit: 1—by means of an electric motor and screw-gear; 2—by means of mechanically driven worms placed under the floor and screw gear; 3—by means of comprest air.

A small electric motor is connected with a pinion and gear which in turn drive a vertical screw in the base of the seat. This screw registers with an "internal nut" (no, Ella, not the "nut" in the chair) in the piston of the chair as the detail illustration shows, so that when the screw is turned in one direction, the chair will be raised, and when it is turned in the other, the chair will be lowered. The running of the motor is positively controlled by the push button placed on the arm of the chair.



You Must Not Fail to Visit the Summer Resorts This Year. They Promise to be More Alive Than Ever Before. For Example—Behold This Wonderful Amphibian of the Sea, Air and Earth. The Inventor Patented and Described Everything But the "Fare." Anyhow, We Are Going to Take Out "Accident Insurance" Before Starting on a Trip.

Behold, the Rising and Falling Electric Opera Chair. "It's a Hard Job to Keep the Old Man at Home Now," Is the Complaint of Some Wives, But Can You Imagine What Show Wifey Is Going to Have to Keep "His Nibs" at Home by the Fire-side with His Slippers on, When the 10-, 20- and 30-Cent Vaudeville Show Around the Corner Affords Such an Enticing, Bacchanalian and Irresistible Saturnalia as This? Wow! Wow! Three Booms and a Tiger for Inventor Adsit ('at's It).

AN AMPHIBIAN LAND, WATER AND AIR HYDROPLANE.

THE accompanying illustration shows one of the latest inventions in the realm of hydroplanes and this particular species might well be classified as an *amphibian* of the first water. As its inventor states in his patent,—yes, he has really been granted a patent by Uncle Sam on this marvelous contraption—his airship may be used in the air, thru water or upon the land with equal facility. The inventor provides in his design for the combination of a lighter than air or buoyant flying machine with a watertight passenger compartment. Thus he has given us a vehicle which may be used on inundated or marine surfaces, and the vehicle is further provided with wheels, in such a manner as to move readily over any ground surface. The machine is fitted with suitable motors, planes and rudders, all of which are accessible and controllable from the interior of the enclosed cab of the airship. This remarkable hydroplane should prove a great boon to the management of summer resorts, who are forever on the watch for something really new and novel. As our illustration discloses, a great variety of pleasure is afforded the passengers who embark on a voyage of adventure in this hybrid airship.

The superstructure consists essentially of a cylindrical metallic tube having a cigar-shaped front end and an outer wall formed of a number of longitudinal ribs, which are in turn connected to an inner encircling band, thus forming a substantial framework for the ballonets or gas bags, which are used to give the airship the desired buoyancy. The car attached to the superstructure and ballonet frame at the bottom, is provided with windows and doors, all of which may be sealed hermetically from the interior of the car, so that the car may be run thru the water, fully submerged, when desirable or necessary, and in any event the passengers are assured of a most delightful trip among the fishes.

At the rear end of the car is a revolving screw for propelling the hydroplane thru the water, while a rudder is also used to control the direction of the airship in its flight thru the water. On top of the ballonet superstructure, the inventor places two masts for the support of a radio antenna one of which may act as a flag pole. Ar-

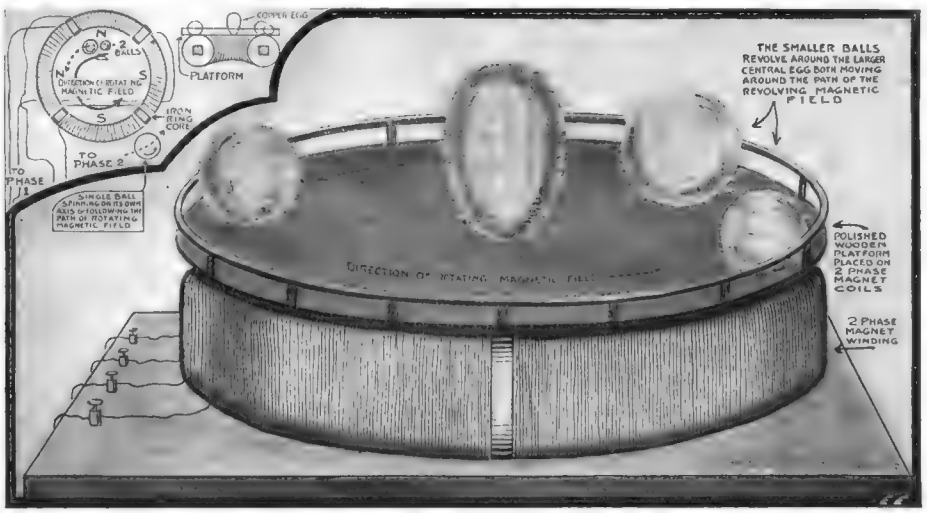
(*Continued on page* 815)

Tesla's Egg of Columbus

How Tesla Performed the Feat of Columbus Without Cracking the Egg

PROBABLY one of the most far-reaching and revolutionary discoveries made by Mr. Tesla is the so-called *rotating magnetic field*. This is a new and wonderful manifestation of force—a magnetic cyclone—producing striking with any speed desired. Long ago, when Tesla was still a student, he conceived the idea of the rotating magnetic field and this remarkable principle is embodied in his famous *induction motor* and system of transmission of power now in universal use.

In this issue of the ELECTRICAL EXPERIMENTER Mr. Tesla gives a remarkable account of his early efforts and trials as an inventor and of his final success. Unlike other technical advances arrived at thru the usual hit and miss methods and hap-


COPPER EGG
2 BALLS
DIRECTION OF ROTATING MAGNETIC FIELD
PLATFORM
IRON RING CORE
TO PHASE 2
TO PHASE 1
SINGLE BALL SPINNING ON ITS OWN AXIS & FOLLOWING THE PATH OF ROTATING MAGNETIC FIELD
THE SMALLER BALLS REVOLVE AROUND THE LARGER CENTRAL EGG BOTH MOVING AROUND THE PATH OF THE REVOLVING MAGNETIC FIELD
POLISHED WOODEN PLATFORM PLACED ON 2 PHASE MAGNET COILS
2 PHASE MAGNET WINDING

Copyright, 1919, by E. P. Co.

Fig. 2. Illustrating the Polyphase Coil and Rotating Megnetic Field Which Caused Copper Eggs to Spin. Fig. 3. Insert: Detail of Coil Apparatus Showing Coil Connections to Different Phases.

phenomena which amazed the world when they were first shown by him. It results from the joint action of two or more alternating currents definitely related to one another and creating magnetic fluxes, which, by their periodic rise and fall according to a mathematical law, cause a continuous shifting of the lines of force. There is a vast difference between an ordinary electro-magnet and that invented by Tesla. In the former the lines are stationary, in the latter they are made to whirl around at a furious rate. The first attracts a piece of iron and holds it fast; the second causes it to spin in any direction and

Fig. 1. This hitherto unpublished photograph is extremely interesting as it shows not only "Tesla's Electric Egg" apparatus in the center of the background, but also a comprehensive view of a corner of his famous Houston Street laboratory of a decade ago. At the left may be seen a number of Tesla's oscillators or high frequency generators, while in the rear may be noted a large high frequency transformer of the spiral type, the diameter of which was a little over nine feet. The electric egg apparatus comprising a two-phase A.C. circular core and winding, rests on a table, and this particular model measured about two feet across. In making the demonstrations, Tesla applied as much as 200 H.P. from a two-phase alternator to the exciting coils, and so intense was the revolving magnetic field created in the surrounding space, that small delicately pivoted iron discs would revolve in any part of the hall, and a great many other devices could be simultaneously operated from this magnetic field when thus excited. The frequency of the two-phase A.C. energizing the coils, was varied from 25 to 300 cycles, the best results being obtained with currents of from 35 to 40 cycles. This laboratory was lighted by Tesla's vacuum tubes, several of which may be seen on the ceiling, and each of which emitted 50 C.P. The coil resting on three legs and observed in the immediate foreground is the primary of a resonant Tesla transformer which collected energy from an oscillatory circuit encircling the laboratory, no matter in what position the transformer was placed. A low tension secondary of one or two turns of heavy cable (not visible) was provided for stepping down the energy collected by "mutual induction," and supplied the current to incandescent lamps, vacuum tubes, motors and other devices. When the circuit around the hall was strongly excited, the secondary furnished energy at the rate of about three-quarters of one horse-power.

hazard experimentation, the rotating field was purely the work of scientific imagination. Tesla developed and perfected, entirely in his mind, this great idea in all its details and applications *without making one single experiment.* Not even the usual first model was used. When the various forms of apparatus he had devised were tried for the first time they worked exactly as he had imagined and he took out some forty fundamental patents covering the whole vast region he had explored. He obtained the first rotations in the summer of 1883 after five years of constant and intense thought on the subject and then undertook

the equally difficult task of finding believers in his discovery. The alternating current was but imperfectly understood and had no standing with engineers or electricians and for a long time Tesla talked to deaf ears. But, ultimately, his pains were rewarded and early in 1887 a company bearing his name was formed for the commercial introduction of the invention.

Dr. Tesla recently told the editors an amusing incident in this connection. He had approached a Wall Street capitalist—a prominent lawyer—with a view of getting financial support and this gentleman called in a friend of his, a well-known engineer at the head of one of the big corporations in New York, to pass upon the merits of the scheme. This man was a practical expert who knew of the failures in the industrial exploitation of alternating currents and was distinctly prejudiced to a point of not caring even to witness some tests. After several discouraging conferences Mr. Tesla had an inspiration. Everybody has heard of the "Egg of Columbus." The saying goes that at a certain dinner the great explorer asked some scoffers of his project to balance an egg on its end. They tried it in vain. He then took it and cracking the shell slightly by a gentle blow, made it stand upright. This may be a myth but the fact is that he was granted an audience by Isabella, the Queen of Spain, and won her support. There is a suspicion that she was more imprest by his portly bearing than the prospect of his discovery. Whatever it might have been, the Queen pawned her jewels and three ships were equipt for him and so it happened that the Germans got all that was coming to them in this war. But to return to Tesla's reminiscence. He said to these men, "Do you know the story of the Egg of Columbus?" Of course they did. "Well," he continued, "what if I could make an egg stand on the pointed end without cracking the shell?" "If you could do this we would admit that you had gone Columbus one better." "And would you be willing to go out of your way as much as Isabella?" "We have no crown jewels to pawn," said the lawyer, who was a wit, "but there are a few ducats in our buckskins and we might help you to an extent."

Mr. Tesla thus succeeded in capturing the attention and personal interest of these very busy men, extremely conservative and reluctant to go into any new enterprise, and the rest was easy. He arranged for a demonstration the following day. A rotating field magnet was fastened under the top board of a wooden table and Mr. Tesla provided a copper-plated egg and several brass balls and pivoted iron discs for convincing his prospective associates. He placed the egg on the table and, to their astonishment, it stood on end, but when they found that it was *rapidly spinning* their stupefaction was complete. The brass balls and pivoted iron discs in turn were set spinning rapidly by the rotating field, to the amazement of the spectators. No sooner had they regained their composure than Tesla was delighted with the question: "Do you want any money?" "Columbus was never in a worse predicament," said the great inventor, who had parted with his last portrait of George Washington in defraying the expenses of the preparation. Before the meeting adjourned he had a substantial check in his pocket, and it was given with the assurance that there was more to be had in the same bank. That started the ball rolling. Tens of millions of horsepower of Tesla's induction motors are now in use all over the world and their production is rising like a flood.

In 1893 Mr. Albert Schmid, then Superintendent of the Westinghouse Electric and Mfg. Co. constructed a powerful rotating field ring with an egg made of copper, and larger than that of an ostrich, for Dr. Tesla's personal collection at the Chicago World's Fair. This piece of apparatus was one of the most attractive novelties ever publicly shown and drew enormous crowds every day. Subsequently it was taken to Mr. Tesla's laboratory and served there permanently for demonstrating rotating field phenomena. In his experiments it was practicable to use as much as 200 *horsepower* for a short time, without overheating the wires and the effects of the magnetic forces were wonderfully fascinating to observe. This is the very ring indicated in the accompanying photograph (Fig. 1), giving a view of Mr. Tesla's former laboratory at 46 E. Houston Street, New York. It is shown in detail in Fig. 2, and the mode of winding is illustrated in diagram (Fig. 3). Originally the two-phase arrangement was provided but Mr. Tesla transformed it to the three- and four-phase when desired. On top of the ring was fastened a thin circular board, slightly hollowed, and provided around its circumference with a guard to prevent the objects from flying off.

Even more interesting than the spinning egg was the exhibition of *planetary motion*. In this experiment one large, and several small brass balls were usually employed. When the field was energized all the balls would be set spinning, the large one remaining in the center while the small ones revolved around it, like moons about a planet, gradually receding until they reached the outer guard and raced along the same.

But the demonstration which most imprest the audiences was the simultaneous operation of numerous balls, pivoted discs and other devices placed in all sorts of positions and *at considerable distances from the rotating field*. When the currents were turned on and the whole animated with motion, it presented an unforgettable spectacle. Mr. Tesla had many vacuum bulbs in which small, light metal discs were pivotally arranged on jewels and these would spin anywhere in the hall when the iron ring was energized.

Rotating fields of 15,000 horsepower are now being turned out by the leading manufacturers and it is very likely that in the near future capacities of 50,000 horsepower will be employed in the steel and other industries and ship propulsion by Tesla's electric drive which, according to Secretary of the Navy Daniels' statement, has proved a great success.

But any student interested in these phenomena can repeat all the classical experiments of Tesla by inexpensive apparatus. For this purpose it is only necessary to make two slip ring connections on an ordinary small direct current motor or dynamo and to wind an iron ring with four coils as indicated in diagram Fig. 3. No particular rule need be given for the windings but it may be stated that he will get the best results if he will use an iron ring of comparatively *small section* and wind it *with as many turns of stout wire as practicable*. He can heavily copper plate an egg but he should bear in mind that Tesla's egg is not as innocent as that of Columbus. The worst that can happen with the latter is that it might be,—er—over ripe! but the Tesla egg may explode with disastrous effect because the copper plating is apt to be brought to a high temperature thru the induced currents. The sensible experimenter will, therefore, first suck out the contents of the egg—thus satisfying both his appetite and thirst for knowledge.

Besides the rotating field apparatus Mr.

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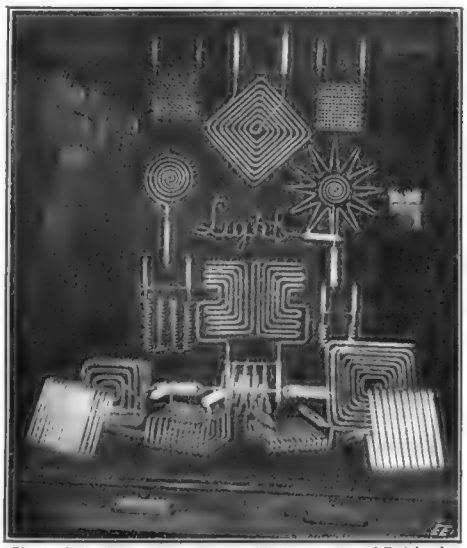

Fig. 4. This photograph represents a collection of a few of Tesla's wireless lamps, such as he proposes to use in lighting isolated dwellings all over the world from central wireless plants. The two lamps at either corner at the bottom are illuminated, owing to the fact that a high frequency oscillator was in operation some distance away when this photograph was being taken. These tubes were filled with various gases for experimental research work in determining which was most efficient.

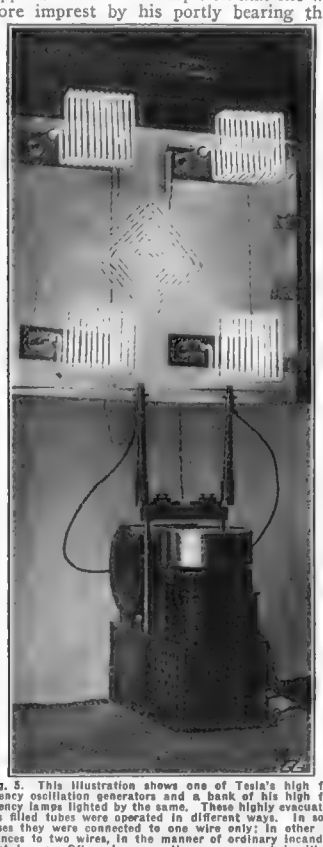

Fig. 5. This illustration shows one of Tesla's high frequency oscillation generators and a bank of his high frequency lamps lighted by the same. These highly evacuated, gas filled tubes were operated in different ways. In some cases they were connected to one wire only; in other instances to two wires, in the manner of ordinary incandescent lamps. Often, however, they were operated without any connection to wires at all, i.e., by "wireless energy". over quite appreciable distances, which could have been greatly extended with more power. The oscillator comprises a Tesla high potential transformer which is excited from a condenser and circuit controller, as described in his patents of 1896. The primary exciting element comprised a powerful electro-magnet actuating an armature, and this circuit was connected with 110 volt, 60 cycle A.C. or D.C. When the oscillator was put into operation, the interrupter actuated by the electro-magnet connected to the 110 volt circuit, became simultaneously the spark gap for the high potential exciting circuit, which included this vibrator, spark gap, a high tension condenser and the primary of the high frequency Tesla transformer. The lamps were connected to the secondary of the latter, the terminals of which are seen in the rear of the machine.

My Inventions

By Nikola Tesla

2. MY FIRST EFFORTS IN INVENTION

I SHALL dwell briefly on these extraordinary experiences, on account of their possible interest to students of psychology and physiology and also because this period of agony was of the greatest consequence on my mental development and subsequent labors. But it is indispensable to first relate the circumstances and conditions which preceded them and in which might be found their partial explanation.

From childhood I was compelled to concentrate attention upon myself. This caused me much suffering but, to my present view, it was a blessing in disguise for it has taught me to appreciate the inestimable value of introspection in the preservation of life, as well as a means of achievement. The pressure of occupation and the incessant stream of impressions pouring into our consciousness thru all the gateways of knowledge make modern existence hazardous in many ways. Most persons are so absorbed in the contemplation of the outside world that they are wholly oblivious to what is passing on within themselves. The premature death of millions is primarily traceable to this cause. Even among those who exercise care it is a common mistake to avoid imaginary, and ignore the real dangers. And what is true of an individual also applies, more or less, to a people as a whole. Witness, in illustration, the prohibition movement. A drastic, if not unconstitutional, measure is now being put thru in this country to prevent the consumption of alcohol and yet it is a positive fact that coffee, tea, tobacco, chewing gum and other stimulants, which are freely indulged in even at the tender age, are vastly more injurious to the national body, judging from the number of those who succumb. So, for instance, during my student years I gathered from the published necrologues in Vienna, the home of coffee drinkers, that deaths from heart trouble sometimes reached *sixty-seven per cent* of the total. Similar observations might probably be made in cities where the consumption of tea is excessive. These delicious beverages superexcite and gradually exhaust the fine fibers of the brain. They also interefere seriously with arterial circulation and should be enjoyed all the more sparingly as their deleterious effects are slow and imperceptible. Tobacco, on the other hand, is conducive to easy and pleasant thinking and detracts from the intensity and concentration necessary to all original and vigorous effort of the intellect. Chewing gum is helpful for a short while but soon drains the glandular system and inflicts irreparable damage, not to speak of the revulsion it creates. Alcohol in small quantities is an excellent tonic, but is toxic in its action when absorbed in larger amounts, quite immaterial as to whether it is taken in as whiskey or produced in the stomach from sugar. But it should not be overlooked that all these are great eliminators assisting Nature, as they do, in upholding her stern but just law of the survival of the fittest. Eager reformers should also be mindful of the eternal perversity of mankind which makes the indifferent *"laissez-faire"* by far preferable to enforced restraint. The truth about this is that we need stimulants to do our best work under present living conditions, and that we must exercise moderation and control our appetites and inclinations in every direction. That is what I have been doing for many years, in this way maintaining myself young in body and mind. Abstinence was not always to my liking but I find ample reward in the agreeable experiences I am now making. Just in the hope of converting some to my precepts and convictions I will recall one or two.

BOYS will be boys, the world over. The Boy Tesla was no exception to the universal rule, as this, his second autobiographical article clearly proves.

Mr. Tesla in his own inimitable, delightful way, here paints with a literary artist's brush his own intimate boyhood in charming as well as vivid colors.

We have often heard of Tesla, the dreamer. But if he is entitled to the epithet, his early boyhood certainly fails to reveal it. Tesla did not allow much grass to grow under his feet while a boy, for he assuredly was a strenuous, red-blooded youngster.

You will wish to read all about the greatest inventor's early boyhood. It is doubly valuable because it comes from his own pen. We promise you an interesting twenty-minutes' entertainment.

—EDITOR.

This Photograph Shows In the Background the House in Which Mr. Tesla's Family Resided. The Edifice at the Right Is the "Real Gymnasium" Where He Studied. The Ecclesiastic Gentleman Is His Uncle, the Metropolitan of Bosnia, Who Was a Great Statesman and Who Thwarted the Designs of Austria Upon Serbia at a Critical Period.

A short time ago I was returning to my hotel. It was a bitter cold night, the ground slippery, and no taxi to be had. Half a block behind me followed another man, evidently as anxious as myself to get under

(*Cont. on page* 839)

An interesting study of the great inventor, contemplating the glass bulb of his famous wireless light. A full description of the invention will appear shortly in the ELECTRICAL EXPERIMENTER. *This is the only profile photograph of Mr. Tesla in existence. It was taken specially for the* ELECTRICAL EXPERIMENTER.

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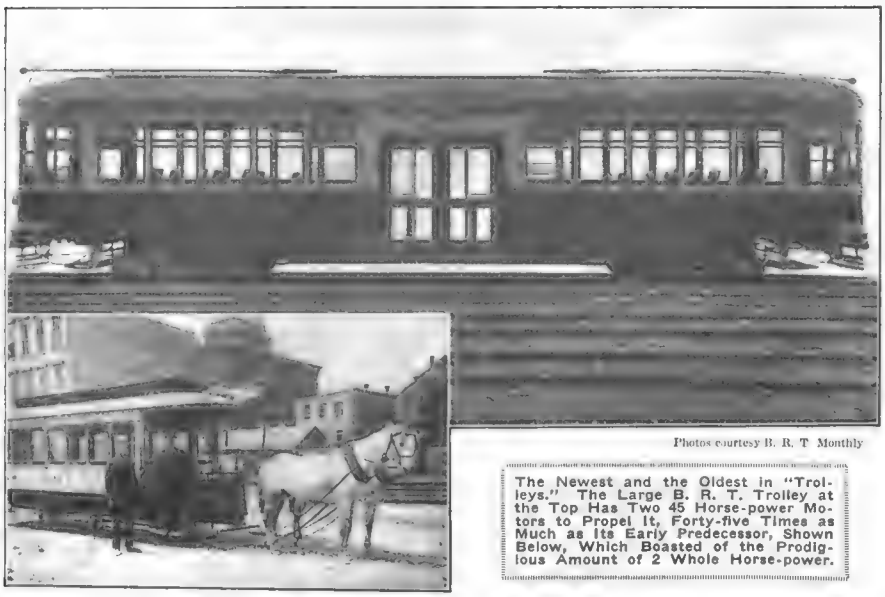
Oldest and Newest Styles in Trolleys

VERY interesting indeed from a historical point of view are the accompanying photographs, which show respectively the oldest and newest style in trolleys, in the greatest trolley town in the universe, Brooklyn, N. Y., the home of the Brooklyn "Rapid" Transit. The photograph is of an old horse-drawn car of the vintage of 1889. Conductor Buck is seen standing alongside of the car, and it is interesting to note that the motormen in those days did not wear uniforms. Shades of Frank Julian Sprague! If the motormen of today only wore frock coats like this one does. He would be so busy reciprocating the attentions of the female passengers and passing the tea cups that we would never get on the job. Well, as we were saying, this was the latest style car—in 1889, and what is also interesting, Conductor Buck is still with the B. R. T.



Photos courtesy B. R. T. Monthly

The Newest and the Oldest in "Trolleys." The Large B. R. T. Trolley at the Top Has Two 45 Horse-power Motors to Propel It, Forty-five Times as Much as Its Early Predecessor, Shown Below, Which Boasted of the Prodigious Amount of 2 Whole Horse-power.

The larger photograph shows one of the very latest Brooklyn Rapid Transit Company's electric trolley cars, which instead of being rated at (2) horse-power, as was the 1889 model, develops the prodigious amount of 90 horse-power (each car having two 45 horse-power motors), or *forty-five times as much*. Note the great length of the modern electric trolley car and its greatly increased passenger carrying capacity compared to the old-timer of a generation ago. Now we can speed along home from the theater or from business in an electric trolley at the rate of thirty miles an hour and think nothing of it, but thirty years ago our fathers and grandfathers had to be content to travel homeward after business or the opera in one of these two-by-twice soap-boxes on wheels, pulled by two horse-power, but not always two powerful horses. When heavy snows came, it would sometimes require six to eight horses to pull the car, especially if heavily loaded.

But several of our friends recollect some interesting experiences. For instance when the horse-car got uncontrollable while descending a hill! Here's what happened many a time; the car knocked the horse down and ran up on top of him; then the passengers tumbled out post haste and helped the crew (he was a fine fellow) pull the car off the horse! And you paid as you entered, Oh! yes. If you didn't pile up front and slip your jitney in the fare box, the driver (he was the whole show) bawled you out properly. When you didn't have the change, the motorman past you an envelope containing change for your bill, and you then selected the fare and deposited it in the fare box. This wonderful mechanical masterpiece had an oil lamp inside it, so that the driver could see that you actually deposited the fare.

Electricity was a long time finding its way to trolley roads. The electric motor was developed at that time sufficiently to be adaptable for the propelling of trolley cars, but the complete details for the distribution of the current had not been fully worked out and developed to any appreciable extent. About the only thing electrical around this early traffic carrier was the "bell," and more often than not this was simply a large clapper intended to be yanked with a piece of cord. Horse-drawn trolleys, or "horse-cars" as they used to be called in the good old days, only disappeared from the streets of New York about a year and a half ago. Up to this time horse-cars were also used on Houston Street—the greatest attraction ever to out-of-town visitors. They talked about them for weeks and weeks and weeks.

HISTORIC ELECTRIC SWITCH-BOARD AND DYNAMO.

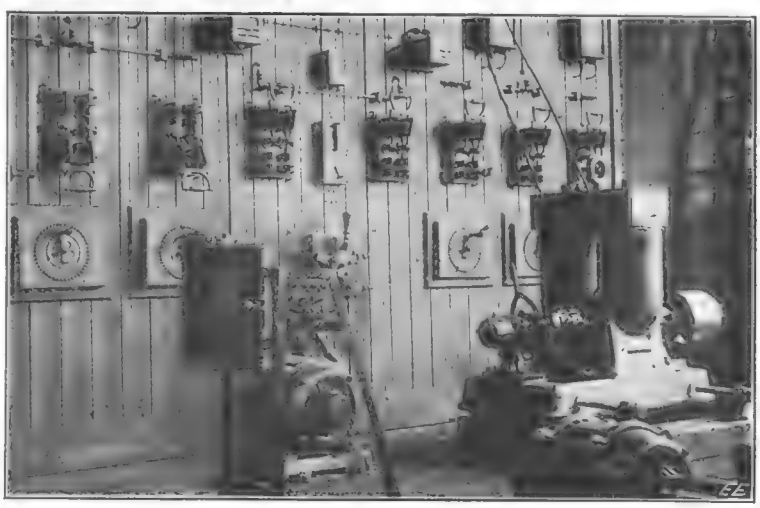
By J. Locketz.

THE electric switchboard, together with the 15 kilowatt generator shown in the accompanying photograph forms a very interesting link in the history of electric light and power development. This switch-board, as well as the dynamo, date back over thirty years and were used until recently by a western railroad when it was superseded by modern apparatus. The historic switch-board and dynamo have been donated to the Dunwoody Institute at Minneapolis.

The first thing that one notices on these old style switch-boards is that they are made of wood. A wooden switch-board was all right some years ago when 110 or 220 volts potential was considered a fairly "high" one, but nowadays when we have power developed at such tremendous voltages as 50,000 to 100,000, and even as high as 150,000 volts, there is required a better insulator than wood, such as marble.

The 15 kilowatt generator will be familiar to electricians as one of the famous old Edison machines of the bi-polar, vertical

(*Continued on page* 808)



A Wooden Railway Switchboard of Historic Interest. The 15 K. W. Edison Dynamo of Early Vintage, at the Right, Is Also of Interest. The Motor and Controller at Left Are of Modern Build.

A "White Coal" Motor to Harness the Tides

From time immemorial men have been active in trying to evolve methods that will relieve humanity from physical toil. The worldwide campaign for increased efficiency is in a large degree dependent upon this same desire to be relieved from physical labor and there is a demand everywhere for cheap power, which can, as everyone knows, be best supplied by water power.

It is claimed by Government officials that the United States has more than 40,000,000 horse-power of undeveloped water power within its boundaries. If this is true, it represents an amount of power corresponding to the amount of energy that would be derived from about 300,000,000 tons of coal worth about $600,000,000 a year in the boiler furnaces.

© International Film Service

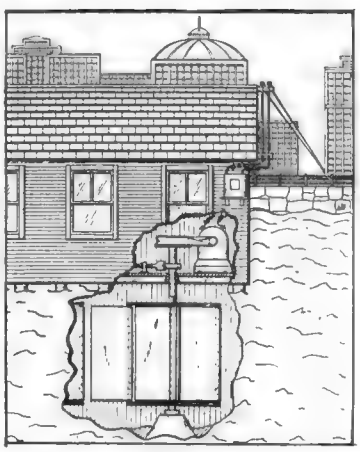
Model of the New Tidal Motor and Its Inventor, Mr. P. J. Griffin, of Boston, Who Is Seen at the Left. A Moving Current of Water Works the Device.

A new motor, shown in the illustrations, invented by Mr. P. J. Griffin of Boston, is designed to harness the energy of the tides and generate electricity by this means. The *White Coal Motor*, as it is known, is built on unique principles, being almost devoid of resistance. With this simple motor a farmer may harness the latent power of the nearest stream and generate his own electricity at very low cost. Flowing water is the only power used to generate the electricity.

Mr. Griffin, the inventor, is shown on the left in the photograph.

The inventor makes use of two sets of crosses, used as arms and mounted on a concave shaft. Secured between the outer ends of said arms are a set of flaps or wings; these wings or planes are held in place on one of their vertical edges between the outer ends of said cross arms by means of a rod (or pivot, to make a circle of 358 degrees from one side of the concave shaft to the other or opposite. On account of the above radius these wings or flaps take advantage of the same currents in its reverse, identically as that of the forward serving with the same continuous motion without any change whatsoever of any part of the device.

This invention is a cross or disk, not a wheel; it becomes a motor when wholly submerged in a current of water or fluids. The action of said forces upon the power producing planes or wings causes it to rotate and hence it becomes a wheel producing motive power on the upper end of an upright shaft. With this motor wholly submerged in water the inventor claims 1,500 h.p. to 60 square feet of surface of blades with between a five and six-mile current.



As Will Be Seen, This New Tide Motor Is a Cross or Disk. It Becomes a Motor When Wholly Submerged in a Current of Water. The Pivoted Wings Are Actuated by the Water Current, Thus Turning the Vertical Shaft, to Which a Dynamo Is Belted.

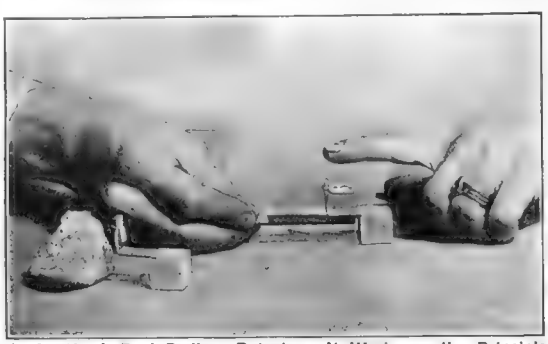
Insulating rods, tongs and similar appliances have been so perfectly developed to-day that linemen often work on charged wires carrying as high as 40,000 volts with comparative safety.

A "RADIUM DETECTOR."

A new detector of *radioactivity* has been evolved by a California inventor, Mr. L. M. Karnasch, and it is a highly sensitive scientific apparatus, constructed on the principle of an Electroscope, by means of which it is possible to distinguish radioactive substances from others. It is claimed that the presence of radium in quantities less than 100,000,000th part of a pound can be detected with absolute certainty.

The Radium Detector consists of two insulating stands, to each of which is fastened a small "flag." A generator, in the form of a stick of electrite or hard rubber composition, 2¾ inches long, ⅝ of an inch in width, and 1/16 of an inch in thickness completes the outfit. The detector is mounted on a small sulfur compound block which forms a ¾ of an inch cube. A small piece of aluminum sheet extends horizontally ¾ of an inch from the cube and has a width of ½ an inch; it is bent into an "L" shape, the vertical side of which stands from each side of the upright aluminum ¾ of an inch above the top of the cube. There is a thin wire stretched taut across the plate and on this wire is placed a small "indicating flag."

Detection of the presence of Radium is accomplisht by the use of two of these detectors placed on a flat surface, preferably a glass top table and at a point of height, convenient for observation. The detectors are placed six inches apart and an initial charge is imparted to each one by means of the brisk rubbing of the generator stick between a folded piece of dry wool cloth or silk. The application of the generator to the detector causes the latter to become actively charged.



At Last! A Real Radium Detector. It Works on the Principle of the "Electroscope." Radioactive Substances Will Dissipate the Charge Rapidly on the "Test" Detector, Causing Its Flag to Fall.

After the detectors have become charged, the small flag raises and stands out in a horizontal position. The substance to be tested is placed under or near the metal part of one of the detectors, without touching it. The second detector is located about six inches away without any substance near it and it is used as a check upon the first detector. The flags of both detectors are then observed for a period of five minutes.

If the flag of the detector near which the substance or ore has been placed, drops from the horizontal position with greater rapidity than the "check up" detector, the substance is then radioactive. The strength of the radioactivity can be approximately determined with this detector by noting the period of time it takes to discharge the detector. The flags will fall in about 8 or 10 minutes when a weak radioactive substance is employed, such as Uranium Nitrat, while Carnotit and pitch blend will cause the flags to fall in from two to three minutes.

Popular Astronomy

Saturn—The Ringed Planet

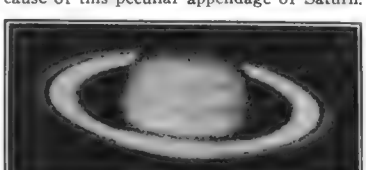
By ISABEL M. LEWIS
OF THE U. S. NAVAL OBSERVATORY

Very Recent Discoveries Tend to Prove with Irrefutable Evidence That the Rings of Saturn Are Not at All Solid as Has Long Been Thought. Instead, the Entire Ring System Is Made up of Tiny Little Moonlets, the Largest of Which Is Probably Not More Than Four Miles in Diameter. These Little Bodies in Their Rotation Around Saturn Revolve as Independent Bodies Floating Free in Space Without Touching Each Other. Collisions, However, Once in a While Are Bound to Occur. In Our Illustration the Arrow Points to One of These Little Moonlets, and in Order to Show Its Size, We Have Depicted Upon It the Lower Part of New York City, as It Would Appear If Viewed from Space about One Mile Above. This Illustration Strikingly Shows the Tremendous Size of the Saturnian System.

NEARLY everyone, with the exception of a few unusually earth-bound individuals, has felt at some time or other a strong desire to gaze at some of the beauties and wonders of the heavens thru a telescope and the one object that all of us wish to see, if, perchance, this desire is to be gratified, is Saturn, whose unusual ring system has so far as we know no counterpart in the sky.

All the planets in the solar system with the exception of the two innermost, Mercury and Venus, are attended by satellites but Saturn, alone, has in addition to a large and imposing family of nine moons, three distinct rings of great dimensions which form a total mass composed of swarms of minute particles revolving around the planet.

Why Saturn should be the only planet to possess such a system of rings has not yet been explained in an entirely satisfactory manner, depending as it does upon the manner of the origin of the entire solar system which it is now agreed could not have followed the course outlined by the Nebular Hypothesis of La Place. The theory of the origin of the Rings of Saturn is involved in the theory of the origin of the solar system and every theory advanced to explain the manner in which the solar system came into existence must satisfactorily explain the cause of this peculiar appendage of Saturn.



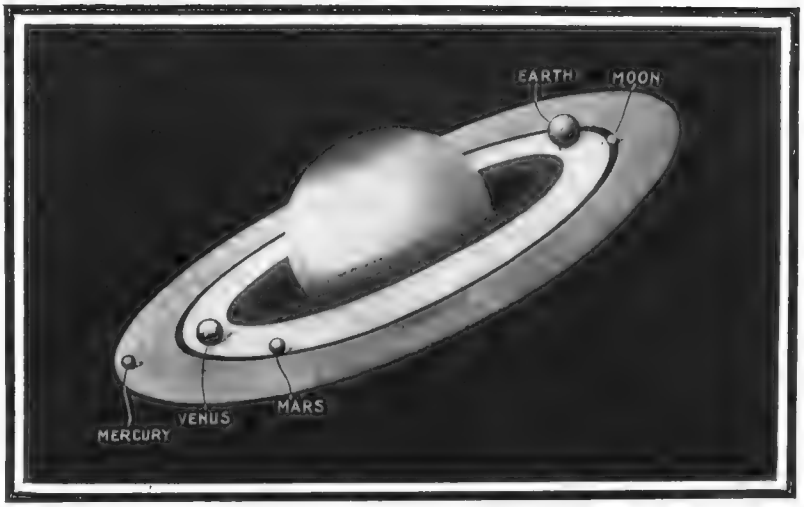
The Planet Saturn, Photographed October 1909 with Mt. Wilson 60" Reflector. This Is an Actual Photograph of the Planet.

There is an interesting law known as "Roche's Law," however, named from its investigator, that states that no satellite of a planet can exist intact within 2.44 . . . times the radius of the planet. This limit is spoken of as "Roche's Limit" and applying it to the planet Saturn we find that the rings of Saturn fall within this limit. It does not necessarily follow from this that the minute particles of which the rings are composed are the shattered remains of one small satellite but rather that they are the material from which a satellite might have been formed were it not so close to the planet. Within "Roche's Limit" the mutual attraction of the various particles for each other that would tend eventually to gather them into one body is overcome by tidal forces that arise from such close proximity to the huge planet. The stress and strain of such forces is so great that no grouping of particles can take place. This explains, possibly, why the rings continue

to exist in their present condition. The total mass of the rings is known to be very small, for they do not disturb the motions of any of the nearer and smaller satellites, tho tiny Mimas six hundred miles in diameter is only thirty-one thousand miles beyond the outer edge of the outer ring.

An interesting observation was made a year or so ago of the passage of the rings of the planet between us and a star. Tho the light of the star was diminished to one-fourth of its normal brightness when the rings past before it, at no time was its light entirely eclipsed by any of the particles. It was computed that if the diameters of any of the individual particles had amounted to as much as three or four miles the star would have been temporarily eclipsed. An upper limit for the size of the moonlets was thus obtained. The average diameter of the particles is probably much less than three miles.

The thickness of the ring system is not over fifty or one hundred miles, but its total diameter is one hundred and seventy-two thousand miles. There are, in all, three concentric rings (see Fig. 1). The faint inner ring, known as the "crape" ring, is invisible in a telescope under four inches in aperture. According to extensive measurements by Barnard of the dimensions of the planet and its ring system the width of this inner ring is eleven thousand miles. Just beyond the crape ring is the chief, bright ring, eighteen thousand miles in width. It shades gradually in brightness from its juncture with the crape ring to its most luminous portion at its outer edge, which is separated from the third or outer ring by a gap two thousand two hundred miles in width, known as Cassini's Division. The third or outer ring is eleven thousand miles wide, and is less bright than the central ring. The inner edge of the inner ring is but six thousand miles above the surface of the planet. On account of the curvature of the planet the ring system is invisible from the north and south pole of Saturn. As is the case with the satellites of a planet the inner particles of the rings revolve around the planet more rapidly than the outer particles. The innermost particles of the crape ring require but five hours for one journey around Saturn while the outermost particles of the outer ring require one hundred and thirty-seven hours, or nearly six days to complete one revolution.



In Order to Understand How Tremendously Large the Saturnian System Is, Our Artist Projected upon the Rings of Saturn All of the Minor Planets, Including the Earth. It Should Be Understood That These Rings Are Not Solid, But Are Merely Composed of Small Little Moonlets (See Large Drawing on Opposite Page). It Will Be Noticed That If All the Minor Planets and Our Own Moon Were Laid Side by Side, They Would Just About Cover the Breadth of Saturn's Rings. The Moon Is Just Wide Enough to Bridge the Gap Existing between the Outer and the Second Ring.

Comparative Sizes of the Nine Satellites of Saturn, Arranged in the Order of Their Distances Outward from the Planets (Reading from Top to Bottom). Titan Is the Exact Duplicate of the Planet Mercury in Size, and Japetus Is Very Nearly Equal to Our Own Moon In Size.

In addition to the gap in the rings known as Cassini's Division several other fainter divisions exist. If a group of moonlets were to revolve around the planet in the positions marked by these gaps their periods of revolution would be commensurable with the periods of several of the satellites of Saturn. As a result the attraction exerted on such particles by these satellites would gradually disturb their motion in such a way as to draw them away from these positions. It is owing, therefore, to the attractions of the satellites of Saturn for the moonlets that these gaps in the rings exist.

It results from the disturbances produced in the motion of the moonlets by the other satellites of Saturn that collisions are bound to occur occasionally among the various particles. When two particles collide the period of revolution of one or both of them is reduced and as a result collisions tend to bring the moonlets gradually closer and closer to the surface of the planet. The dusky inner ring, it has been suggested, may consist largely of particles whose periods have been continually shortened by collisions.

Saturn may, therefore, lose its ring system in the course of time thru its gradually being drawn down upon the planet by collisions of the various particles until all of the material is finally swept up by the planet. Such a change would probably require millions of years, however, as collisions are probably, on the whole, infrequent. It is possible that the ring system of Saturn may have been much more extensive in the past than it is now and other members of our solar system may have had such appendages in the far distant past.

The appearance of the rings of Saturn as viewed from our planet changes periodically as a result of the revolutions of the earth and Saturn around the sun, which places them in constantly changing positions with reference to each other. The rings lie in the plane of Saturn's equator, which is inclined twenty-seven degrees to its orbit and twenty-eight degrees to the Earth's orbit.

Since the position of the equator remains parallel to itself while the planet is journeying around the sun it happens that half the time the earth is elevated above the plane of the rings and the remainder of the time it lies below the plane of the rings. Twice in the period of Saturn's revolutions around the sun, which occupies nearly thirty years, the earth lies directly in the plane of the rings and at this time the rings entirely disappear from view for a short time. The last disappearance of the rings of Saturn took place in the fall of 1907 and the next disappearance will occur in November, 1920. Between these two dates the southern surface of the rings remains the visible one. Half way between the two dates of disappearance the rings are tilted at their widest angle with reference to the earth and they are then seen to the best advantage. They are now becoming narrower and narrower and as the date of their disappearance approaches they will appear more and more like a line of light extending to either side of the planet's equator. Even in the most powerful telescope the rings entirely disappear from view for a few hours at the time the earth lies exactly in the same plane. It is at this time that the ball of

(*Continued on page* 821)

Fig. 1 Shows the Dimensions of the Ball and Rings of Saturn and the Orbits of the Five Inner Satellites.

How Jimmy Saved the Bank

By F. W. RUSSELL

AS the hands of the big clock in the office of the First National Bank pointed nine, old Mr. Hutchinson past between the long rows of desks towards the door of the big burglar-proof safe. For the last ten years he had past along that same isle and at exactly the same hour. He reached the door and put his hand on the huge nickle-plated handle, by means of which the door was pulled open. The great weight was so delicately balanced that only a slight pull was necessary to open it, but this time it did not yield to the usual effort; Mr. Hutchinson applied all his strength to the task, but the door did not yield an inch. What could be wrong?

Mr. Wallace, the president of the bank had wanted an absolutely burglar-proof safe, so his brother, an Electrical Engineer, had undertaken to design one, which he claimed would foil the efforts of the most ambitious cracksman. It had a marvelous time-lock consisting of five clocks timed to a hair. These, beginning at fifteen minutes to eight, closed five different contacts in a special motor circuit; that is, the first contact was closed at a quarter to eight, the next at exactly eight, and so on at intervals of fifteen minutes, until the last contact was closed at a quarter to nine, starting an induction motor which drew the bolts. The current for this motor was brought in thru the top of the safe. Two holes had been made here which were comparatively small at the top and bottom but which bulged out at the center. Heavily flanged brass rods had been set in these holes and porcelain molded around them. These were protected by a thick layer of concrete which covered the safe on all sides, excepting the front. The current which operated the clock contacts, was supplied by a small storage battery kept in the safe and charged every day.

Mr. Hutchinson's first thought was that he might have been too soon, for even his almost machine-like actions might have for once been at fault, but no, the huge clock above the safe by which the time mechanism was set every evening, showed exactly twelve minutes to nine. The safe was three minutes late already! He tried the door again in order to be sure that he was in no way at fault, for he took great pride in his reputation for punctuality and promptness, and to his mind nothing could be more humiliating than to be laughed at by some of the bank clerks simply because of some thoughtless mistake. But his utmost exertions were futile. The giant door did not yield a fraction of an inch. He proceeded hurriedly, to keep from being questioned, to the office of Mr. McGinnis, Mr. Wallace's secretary, who took charge of affairs when his chief was away.

"Mr. McGinnis," he gasped breathlessly, "the safe won't open!"

Mr. McGinnis gazed at him in blank astonishment.

"No sir! no sir!" He raced on, getting his breath in gulps. "I went there at the usual time sir, and the door would not give. I know I was not ahead of time, for I waited nearly five minutes and tried again. I pulled with all my might, sir."

He paused and looked inquiringly at the secretary, who had sunk into one of the large leather arm chairs against the wall, and sat gazing at the floor. Suddenly he got up and looked at his watch, started to sit down again, changed his mind and began to pace the long office thoughtfully. Mr. McGinnis was a man who had never in the experience of anyone, been known to become visibly excited, but Mr. Hutchinson could see that he was now making a strong effort to contain himself. Finally he came to a halt before Mr. Hutchinson, and with his eyes still on the floor he began:

"Hutchinson, that safe must be opened! I have no idea what can be the matter; I have no idea how to open it—but it must be done. There are some papers in there that must be gotten at by noon, or we will be practically ruined. We can borrow enough money to carry us thru the day, but those papers have got to be attended to. Mr. Wallace as you know, left yesterday morning for a short cruise on his yacht. I do not think he knows of any way to open it, but it would be best to ask him and inform him of the situation."

"Ask him? How are you going to ask him?" inquired the impatient Hutchinson.

Jimmy Turned to Mr. McGinnis—"That Motor That Draws the Bolts Is Exactly In the Middle of the Door, Isn't It?" he Asked. "Yes, Yes, Exactly. . . . But What are You Going to do?" Said Mr. McGinnis. All Eyes Were Turned Inquiringly on Jimmy, Who Stood on the Desk Holding a Push Button In His Hand and Listening Intently With His Ear Glued Against the Door. Suddenly a Low Hum Was Heard and Then a Click Which Was Unmistakable. A Cheer Burst From the Surrounding Bank Attaches—Jimmy Had Saved the Bank.

Mr. McGinnis looked at him reprovingly. "He keeps in touch with his home thru his son Jimmy's wireless. We will go and see him at once; you must go with me."

They left the building together and hailed a passing taxi. After giving the direction, Mr. McGinnis settled back in the seat with the outward appearance of a man without a worry. Mr. Hutchinson sat with clasped hands, and silently shook his head. He had no faith in this wireless business, or in fact in anything, now that the safe which had always been his pet had failed him. They stopt on the way, and Mr. McGinnis explained the situation to the Citizens National Bank, securing a sufficient loan to carry them thru the day. The car soon cleared the crowded down-town district and sped along the smooth streets, until after a short ride it drew up before the white marble home of the Wallaces.

The door was opened by John, the butler, who informed them that Jimmy was at home. He was at that moment in his workshop, or in good American, his "joint."

Was the gentlemen's business very important? It was. Well John might venture into those dangerous regions if that was the case. John went off slowly showing no enthusiasm for his task. There were memories still fresh in his mind of electrified door-knobs that stuck to the hand, and one rug in particular on which he had shown a surprising amount of activity. He approached the door cautiously and knocked.

"Hello, who is it?" came a voice from within.

"Mr. McGinnis and Mr. Hutchinson are down-stairs wishing to see you."

"I can't come down, am too busy; tell them to come on up." Jimmy said this last standing in the open door. He was a tall slender young fellow, but well built, with a shock of brown hair, above a pleasant face. He was a typical "Bug"—always had a binding-post or a piece of wire in his pocket, and spent all his time collecting "junk" or "making somethin."

Mr. McGinnis and Mr. Hutchinson were shown up and entered the room. It was a regular "joint" all right; wire on the floor, hung from the ceiling and draped along the walls, switches nailed up here and there, and tables and chairs covered with tools and apparatus. Jimmy swept two chairs clean, but his visitors remained standing.

"Jimmy," the secretary began hurriedly, for the first time in many years not pausing to weigh his words, "The bank is in great danger. The safe won't open and there are some very important papers in it which have to be attended to. I want you to call your father, and ask him if there is any way to open it. You can get him, can't you?"

"What's this, you say, the safe won't open?" burst out Jimmy, looking dazedly at Mr. McGinnis.

"Yes, yes, and I want you to ask your father if he knows any way to open it. I say, you can get him, can't you?"

"O, sure, of course, just a minute." Jimmy dashed to his wireless table and threw in the antenna switch. In a moment the hum of the rotary gap was being drowned by the high-pitched spark, as the call of his father's yacht was being tapt out rapidly. After the second trial Jimmy was answered by the Yacht's radio operator.

After a few minutes, Jimmy rose from the table with a downcast look. The two men could read his mind before he had opened his mouth. "He don't know—he's all excited. That's natural enough tho. He's coming right back." Jimmy stood for some time looking at the floor in a thoughtful attitude. Finally, as Mr. McGinnis started to go, he called him back. "Wait a minute, there ought to be some way to open that safe; sit down and think; there is no use getting excited."

Mr. McGinnis was far from being excited. "There is no use," he said, starting to go again. "You know how your Uncle brags about that safe, and he knew what he was doing when he designed it. We will just have to wait and see what happens."

"No, you have got the wrong dope," said Jimmy, his right hand idly turning the rotor (revolving member) of a medium size 220-volt induction motor on an adjacent table. "I'll admit that my Uncle is a bright man, but he may have mist something. Let's see; that storage battery must have gone wrong because that motor is as simple as they go. You know an induction motor has—oh! I've got it! maybe?"

Mr. Hutchinson gazed at him in wonder. Mr. McGinnis after his first astonishment rushed up to him and grasping him by the shoulder, stammered out, "What—what—what do you mean?"

"Don't bother me," said Jimmy, busily rolling up a long extension cord, "just tell me, have you got 220 volts A. C. at the bank?"

"Yes, yes," stammered Mr. McGinnis. "Yes, but what——"

Mr. McGinnis obeyed, and Mr. Hutchinson trailed out after him, not having recovered his senses as yet. The car was out in front and the two got in. In a moment Jimmy came running down the steps with a large black bag, which was apparently very heavy. The big car dashed thru the streets, narrowly missing several bewildered pedestrians and shaving passing vehicles by the fraction of an inch. As the car drew up in front of the bank, Jimmy was out over the door in an instant, dragging his bag along with him. When the secretary reached him, he was busily running the extension cord from a near-by lamp socket to the safe, in the mean time warding off a swarm of inquisitive bank clerks. When he had finished and had attached the two loose cord ends to two more protruding from the motor, he turned to Mr. McGinnis—"That motor is exactly in the middle, isn't it?" he asked.

"You mean the one that draws the bolts? Yes, yes, exactly; I remember that from when your Uncle explained it to me. What are you doing to do?"

"Roll one of these desks over here", was all the answer they got. The order was obeyed by half a dozen clerks, who soon had one of the big flat tops on the required spot. By piling some large books and a file cabinet on top of this, the required level was soon attained. Jimmy lifted up his bag and took something out of it.

Just then a little man in great excitement burst thru the group. "Good heavens!" he exclaimed. "So it is true. I couldn't believe it. What are you doing, James, my boy!"

"Little idea of mine, going to try to open it," said Jimmy, "don't get excited tho; it may not work."

"Going to try to open it?" Mr. Wallace queried dazedly. He had just arrived and had driven to the bank at top speed.

"Ugh, ugh," said Jimmy. Then turning around, "Give us a little juice over here, one of you fellows!" In the scramble which followed some one accidently pushed the button, and the juice was on.

All eyes were turned inquiringly towards Jimmy, who stood on the desk holding a push button which was connected to a round black object on top of the pile of books. Suddenly, he prest the button and bent his ear to the door of the safe; a low hum was heard on the inside and then a click, which was unmistakable.

A cheer burst from the surrounding clerks, and as the desk was rolled away, Jimmy grasped the big nickle plated handle and swung the door wide open. But the mystery was yet to be explained and all eyes were again turned on Jimmy.

"How did you do it, son? How did you do it?" gasped Mr. Wallace, looking with mingled wonder and pride at his young hopeful.

"Oh, it's nothing!" said Jimmy, "You see an *induction motor* has no electrical wire connection between the field and the armature." All nodded understandingly. "And so I figured that if I used a bigger and more powerful field, I ought to be able to spin that armature from the outside; so I just lined them up and you know what happened. Simple little thing, isn't it, when you come to think about it?"

"James, you know that thing—that transformer you were longing for in that catalog the other day? How much does it cost?" asked Mr. Wallace, as he sat down and began to fill out a check.

(THE END)

THE APRIL NUMBER "E. E."

The April number of the ELECTRICAL EXPERIMENTER *will abound with new and refreshing articles. Among those in preparation there are the following attractive contributions:*

"My Inventions"—No. 3 of a series by Dr. Nikola Tesla, the eminent electrical scientist. This paper will describe his wonderful discovery of the "Revolving Magnetic Field"—the forerunner of the Tesla induction motor, which has revolutionized the electrical power industry.

"Do Wireless Waves Travel Above the Earth or Thru It?", by Dr. Lee de Forest. An exclusive feature article which you can't afford to miss.

Electricity—the Hotel Servant of a Thousand Uses. How it furnishes every conceivable want to the hotel guest—all at the push of a button.

"New X-Ray-less Photography of the Bones", by Charles Battell Loomis.

"Will Man Freeze the Earth to Death? Can He Exhaust the Heat-Giving Radium?" by E. T. Bronsdon.

"The 'Noiseless' Phonograph—it don't annoy the neighbors"—by Thomas Reed.

"'Putting It Over' on Fritz. Some radio and other tricks of the war," by K. K. Sammerin.

"New French and American Audions".

"A New Lightweight Commercial Radio Transmitter".

"Experiments in Radio-activity". Part III, by Ivan Crawford.

"Some New Regenerative Vacuum Tube Circuits", by Samuel D. Cohen.

Besides "Experimental Mechanics", New "Experimental Chemistry Questions and Answers", "Physics".

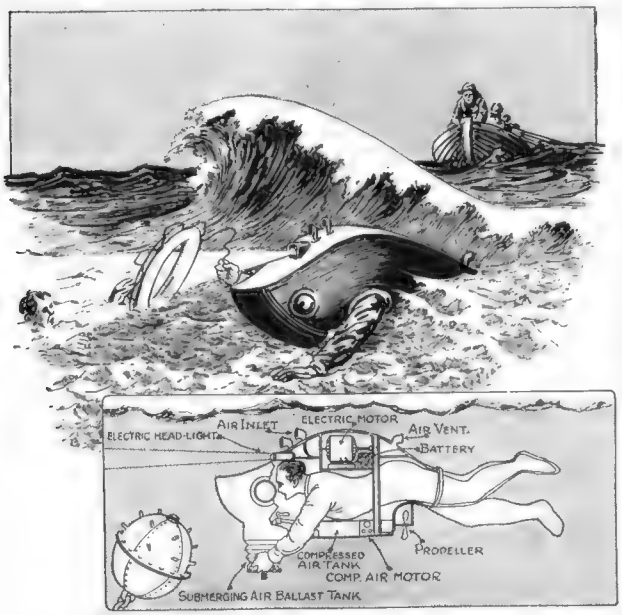
DO IT ELECTRICALLY.

When Milli Ampere first saw Volt
Her charms past all resistance.
A spark coiled in his heart poor colt—
He needed prompt assistance.
And she, tho plighted to old Watt,
Could alternate affection,
So let her eye bolt glances hot,
Right in poor Volt's direction.
The current of Watt's wrath flowed strong!
He vowed Volt should not meter.
For daughter Poly Phase had long
Hoped that Volt would be sweeter.
And so to Milli Ampere, he
A stern note did transmitter,
Requesting she transform, and be,
If possible, less bitter.
So Milli Ampere flirted not,
But knew that it was wise
To regulate the rage of Watt
And with him synchronize.
Then Volt with Poly Phase did fuse—
From her he did not roam.
They rectified divergent views
And started a small Ohm.

—*W. F. Leggett, in Western Electric News.*

Submersible Boat Resembles Sea Monster

THE peculiar looking submersible one-man boat shown in the accompanying view has for its primary object, so its inventor, Mr. Worth R. Barringer, of Denver, Colorado, states—to provide a vessel of this character constructed so as to contain a single occupant and provided with suitable means whereby submergency of the vessel as well as its travel thru the water may be controlled by the occupant. He mentions, among other advantages, that it should prove useful and convenient for submarine observations and in the removal of submerged mines and for various other similar and analogous purposes. Also the inventor claims that his device can be used as a diving suit, and can be readily donned by the individual.



With a Little Ingenuity Amateur Mechanics Can Construct a One-Man Submersible Boat of the Type Here Shown. The Arms and Legs Fit into Flexible Rubber Extensions, the Same as in a Diving Suit. An Electric or Compress Air Motor May Propel the Device.

The body of the submersible diving suit is preferably made of aluminum. The front or nose portion of the body is provided with transparent panes or windows, as shown, thru which the occupant can see either to the right or left and forward. Suitable rubber or other flexible water-proof compartments are adapted to receive the lower limbs of the operator. An electric motor is arranged to operate a propeller, the motor receiving its current from a storage or other battery. But this is not all. The inventor takes Time by the fore-lock and practises safety first. He also supplies a compress-air motor with a storage tank containing air under high pressure for operating it, all of which is used to drive the propeller. Suitable vents are provided for the efflux of vitiated air as well as air inlets or ventilators, which are arranged in the top wall of the body. These vents are fitted with suitable valves, such as the float-ball type, which will automatically close, due to the pressure of the water upon submergence. An electric light bulb is also arranged in the top of the body, which is supplied with current from the storage battery.

Sleeves made of rubber or other suitable flexible material are attached on the front of the body on either side to accommodate the arms. These are fitted with suitable gloves to receive the hands of the operator. To submerge, the "human fish," a collapsible tank is arranged on the under side of the body. The tank is equipt at its lower end with suitable valves and hand-holds. There is also provided a pipe connecting the compress air tank to the upper end of the collapsible bellows tank, in which pipe line there is placed a suitable valve. When it is desired to submerge, the bellows tank is collapsed, the air being expelled from the tank thru suitable valves. This results in the displacement of the vessel, so that it will submerge. When the operator desires to rise to the surface, he withdraws his arm from one of the sleeves and opens a compress-air pipe valve from the storage tank into the collapsible bellows tank, thus expanding it and causing the vessel to rise, owing to the increased buoyancy.

Finally, the inventor mentions that it will of course be understood that the vessel may be provided with an oxygen supply tank, so as to afford an ample supply of oxygen during prolonged submergence of the vessel. If there is anything under the heavens that this inventor forgot, we have failed to perceive it in looking over his patent, but he might have conscientiously attached a 69 cent alarm clock to the rear wall of the inner compartment so as to arouse the submarine explorer from prolonged slumber, which might result disastrously in the event the "ship" became uncontrollable and started off on a long journey toward foreign shores. We presume the sailor carries sufficient tea biscuits in his box to weather the voyage, and providing he has the foresight to procure a few dozen choice tea and bouillon capsules as adapted by the United States Army for emergency rations, he should have a delightful cruise. *Bon voyage!*

PREDICT AERIAL MAIL SERVICE BETWEEN EUROPE AND AMERICA.

All mails between Europe and the United States eventually will be carried by airplane, according to Lord Morris, who has championed a movement before a Parliamentary committee for the establishment of a port of call for Atlantic aërial liners on the west coast of Ireland.

Already, he says, a regular daily mail service by airplane is maintained between England and France without interruption by the weather.

BRITISH TANKS CARRY THEIR OWN "CARPET."

The photograph herewith shows a giant British tank ready to go into action. This tank is fitted with a new superstructure, which comprises a rugged steel wire timber "carpet." It is used to breach shell-holes, gulleys and trenches, in making advances over rough ground. This "carpet" is quickly unrolled when needed, and is very effective on muddy ground. The giant caterpillar treads or belts do not grip into the mud when the carpet is used, and thus one of the greatest drawbacks to the use of the tanks has been overcome. This photograph is one of the most remarkable taken during the war and shows British infantry reinforcements accompanied by tanks, all awaiting orders to "get into it." The smoke from the battle almost obscures the tanks and men in the background of the picture.

© Underwood & Underwood

Unhampered by the Heavy Shellfire. This Re-enforcement of British Infantry Has Been Brought to the Front and Are Awaiting Orders to Get Into It. One of the British Tanks with the New Superstructure, Which Is Used to Carpet the Mud Which the Caterpillar Wheels Do Not Grip, Is Advancing. The Smoke from the Battle Almost Obscures the Tanks and Men in the Background of the Picture.

Experimental Physics

By JOHN M. FURIA, A. B., M. A., (Columbia University)

LESSON NINETEEN

Radio-activity—Experiment 108.

WRAP a photographic plate in a piece of perfectly opaque black paper. Lay a coin on top of the paper and suspend a pinch of the mineral Uranium a little above the coin. Set this aside for a few days, after

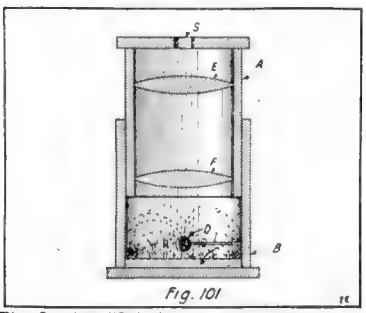


Fig. 101

The Crookes "Spinthariscope," Which Demonstrates In a Popular Way the Wonders of Radium. These Can Be Purchased On the Market.

which time develop the plate. A shadow picture of the coin such as one would obtain after exposure to X-rays will appear on the plate. This is precisely the experiment that Henri Becquerel, of Paris, performed in 1896, which led him to the conclusion that *Uranium is a source of rays that affect photographic plates and which have the power of penetrating opaque objects just as X-rays do.* The rays are known as *Becquerel Rays*, after their discoverer, and the phenomenon is called *Radio-activity*. Shortly after Becquerel's discovery Madame Curie, of Paris, assisted by her husband—Prof. Curie, made an investigation of all the known elements to ascertain which of them possest this same remarkable property that Uranium possesses. She found that *Thorium* in any of its compounds was a radio-active substance (Thorium is the chief constituent of Welsbach gas mantles). During the investigation Madame Curie noticed that *Pitchblende* (the crude ore from which Uranium is extracted) which consists of Uranium Oxid to a great extent, discharged her electroscope (a test for radio-activity) about four times as fast as pure Uranium does. She concluded that the radio-activity of pitchblende was due to some unknown element in it more powerfully radio-active than either Uranium or Thorium. After a tedious and difficult research she succeeded in separating a few hundredths of a gram of this hitherto unknown element from several tons of pitchblende. This new element which she named *Radium* proved to be a million times more radio-active than Thorium or Uranium. Radium has attracted the attention of the foremost scientists the world over.

Before proceeding with the following experiments let us note carefully the following characteristics of Radium. The Radium atom is heavier than any other atom. Radium constantly emits three distinct kinds of rays namely alpha, beta, and gamma which I shall refer to by α, β, and γ respectively. α, β, and γ rays all affect photographic plates, discharge a charged electroscope and are deflected by magnetic fields. α and β, both impart electric charges to bodies they come in contact with. In particular, the α rays are not as penetrating as the β and γ rays; they are deflected by a magnet in a direction opposite to the direction of deflection of β rays and travel at about 20,000 miles per second. The β rays are like cathode rays and they travel at from 50,000 to 180,000 miles per second. The γ rays are not deflected by a magnet but they have greater penetrating power than either the α or β rays. From these properties we conclude that α rays are streams of positively charged particles (atoms of Helium); β rays are negatively charged particles like cathode rays, i. e., electrons and γ rays are irregular pulses like X-rays.

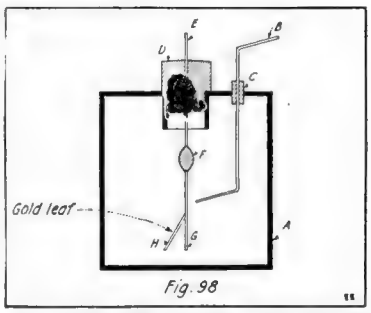


Fig. 98

A Sensitive Model of Gold-Leaf Electroscope Suitable for Use in Radio-Active Measurements.

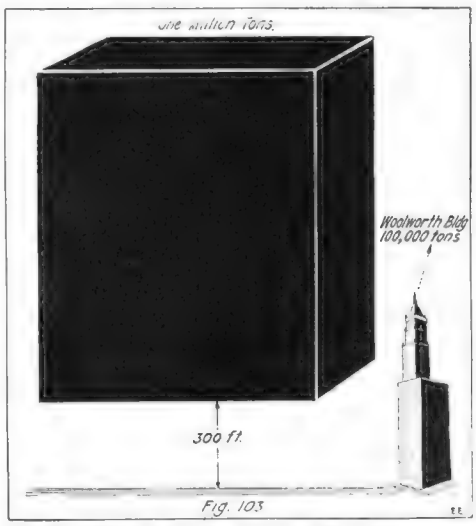


Fig. 103

Almost Unbelievable Is the Fact that the Disintegration of 1 Gram of Hydrogen Liberates Enough Energy to Raise 1,000,000 Tons to a Height of 300 Feet.

Experiment 109.

The goldleaf electroscope, one of the oldest electrical measuring instruments known and which was described in the lesson on "Static Electricity," was used merely as a detector of the presence of an electrical charge. This same instrument in a delicate form is used to measure electric currents of very small magnitudes where other instruments fail. In Fig. 98, A is a metal case (a cocoa can serves admirably; in fact an authority on the subject of radio-activity made the statement that he secured better results with a home-made cocoa can electroscope than with the fancy priced, highly polished commercial instruments). A metal rod E (about 1/32 inch in diameter) passes thru an insulating plug D, made of ebonite, amber or sulfur. C and F represents insulation of the same material as D. B and G are metal rods like E, bent as in the figure (hairpin with the enamel scraped off is quite satisfactory). H is a narrow strip of gold or aluminum foil about one and one-half inches long and 1/32 inch wide. (The narrower the strip the more sensitive the electroscope). To cut the aluminum or gold foil the following method has been found best. Place the foil between two sheets of thin paper. Press the edge of a razor flat against the "sandwich" and carefully saw

(*Continued on page* 806)

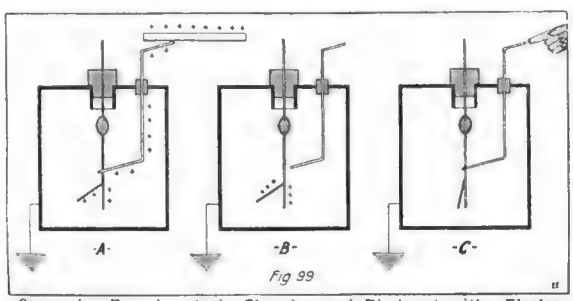


Fig 99

Successive Experiments in Charging and Discharging the Electroscope Used in Radio-Active Measurements.

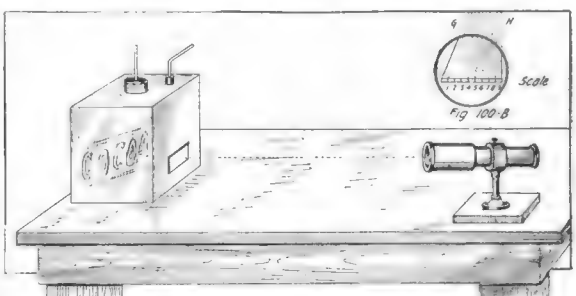


Fig 100-B

Fig. 100-A—Set-Up of Electroscope, Telescope and Scale for Conducting Radium Measurements.

The RADIO LEAGUE of AMERICA
HONORARY MEMBERS
CAPT. W.H.G. BULLARD, U.S.N. NIKOLA TESLA.
PROF. REGINALD FESSENDEN. DR. LEE DE FOREST.
Manager, H Gernsback

Amateurs Win

Alexander Wireless Bill Is Killed

By H. GERNSBACK

THE Alexander Wireless Bill and its amendment as reported in our last two issues has been killed. On January 15th the Merchant Marine Committee and the House of Representatives gave the Administration's movement toward Government ownership of public utilities a very definite set back. By unanimous vote it tabled the bill which was to authorize the Navy Department to take over and operate permanently all radio stations.

As our readers will remember from our January issue the bill was sponsored and urged by Secretary Daniels. Repesentative Bankhead made a motion to table the bill and Chairman Alexander characterised the proposed plan as "a hopeless task." He added: "In view of the sharp difference of opinion both in the Committee and in the House on this subject, it would be impossible to put the bill thru at this session."

As our readers will remember from our January issue, the original Alexander bill proposed to make all wireless stations Government owned, and the present wireless law, the act of 1912 was to be changed to such an extent that the amateurs were to be eliminated entirely from the Radio field.

The Alexander bill and our views thereof were printed in full in our January issue. As this issue, however, did not appear on the news-stands until the 15th of December, and inasmuch as the hearings on the bill began a few days earlier before Mr. Alexander's Committee at Washington, the ELECTRICAL EXPERIMENTER sent out some 50,000 letters to amateurs apprising them of the impending measure. This movement had its immediate result, and official Washington was deluged with a storm of protesting letters, which not only reached Mr. Alexander's committee but every Congressman and Senator of the United States as well. This unparalleled unity of the American amateurs had an instantanous effect in Washington, and even before the hearing started, a number of amendments, all of which favored the amateur more or less were rushed thru, printed and distributed.

There were at least three amendments of which we have record. One of them, the last one dated December 11 was printed in full in our February issue. Before the bill was definitely killed, however, we had information which tended to show that the Government was not ready to make wireless a Government ownership affair. As far as the amateur was concerned we were not at all disturbed, for we said:

"As a matter of fact as things stand

(*Continued on page* 835)

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A Modern St. George. Yes, Mr. Alexander, We Cannot Tell a Lie, He Did It with His Little Pen.

America's Greatest War Invention

The Rogers Underground Wireless

(Special Interview to the ELECTRICAL EXPERIMENTER.)

By H. Winfield Secor
(Associate Member Institute Radio Engineers.)

An invention which has been termed the greatest American war achievement is the Rogers underground and sub-sea radio system. The Rogers system does away entirely with aerial wires, and it is only a matter of months now before all aerial wire systems the world over will be pulled down. Wonderful things have been accomplisht by the new Rogers underground system, chief of which is the total elimination of static and the increase of the loudness of received signals, which is often as high as 5000 times the usual strength. Interference, too, is done away with almost entirely now. The Rogers invention is of tremendous importance and revolutionizes our previous ideas on wireless to an extent never dreamt of before. We urge every one interested in radio to read the accompanying authoritative article which discloses the full technical data on the new system for the first time in any periodical.

THE greatest invention in the field of wireless telegraphy since Marconi first placed commercial radio-communication on a firm basis by his historic experiments in Italy, and later in England, is without a shade of doubt this latest triumph of radio research—the "Underground and Sub-sea Wireless", conceived and developed to a working stage by an American scientist and inventor, James Harris Rogers. Mr. Rogers is known as a second Edison, among his towns-people in Hyattsville, Maryland, where he has lived for many years, and now the whole world acclaims him.

It Is Revealed Now That the Navy Department Had Been Using a Powerful Undersea Wireless During the War. The Instruments and System Were Invented by James H. Rogers, of Hyattsville, Md., and were Adopted by the Navy Department as an Invaluable Addition to the Wireless System of the Navy. The Two Lower Photos Show the Inventor, Mr. Rogers, in His Laboratory at Hyattsville.

Top Photo Shows Antenna Wires Being Placed in River by Mr. Rogers' Assistants. The Inventor Has Found that His System Works Just as Well Under Water as Thru the Earth. All of the High Power Stations in the World, from Nauen and Lyons to Honolulu, Are Heard in Mr. Rogers' Laboratory at Hyattsville, Md., Shown in the Center and Lower Views Herewith. The Author of This Article Also Heard the Transatlantic Stations Coming in Loud and Clear. Mr. Rogers' Invention Is the Greatest in the War and Is so Recognized by the Government.

Photos by International Film Service

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Who is Mr. Rogers?

James Harris Rogers, practically unknown a few years ago in radio circles, except by a few select radio men who were investigating his invention for the Navy Department, has practically become overnight the center of all attractions in the field of science. Mr. Rogers is a son of the confederacy and a veteran of the great Civil War. He has followed electrical experimenting ever since and has been a strong devotee of radio telegraphy since Marconi performed his first experiments in this new branch of applied science. He is a refined, cultured southern gentleman who makes you feel at home at once; an invariable attribute of all of the truly great. Mr. Rogers was one of the first inventors of the "printing telegraph" and his full-sized working models saw actual commercial service on a circuit between Baltimore and Washington, also in New York, back in 1880. These were seen by the writer and are wonderful pieces of mechanism.

The Rogers laboratory, which comprises several large rooms, is lined on all sides with glass cabinets containing electrical apparatus which he has invented from time to time thru his studious career. A novel and original high frequency generator was another of the devices that greatly interested the writer. It employed a jet of water shunted by a large capacity, the stream of water being connected to a high potential source of direct current. High frequency currents of any range up to the limit of audibility, or about 30,000 cycles per second, could be readily obtained with this apparatus. The writer merely cites these facts to substantiate the standing of Mr. Rogers in the scientific field. Hundreds of other electrical inventions have been made by this modest genius of the quiet little Maryland town of Hyattsville, and the principal outstanding fact of all of his work is that he can show you a working model of each of these inventions, unlike many other inventors whose ideas exist only on paper, and which often fall down, miserably, when actually built and tested.

In this connection it is interesting to consider for a moment that not one of the new wireless "static and interference preventers" proposed to the government radio experts during the war, proved practicable in the least.

TRANSMITTING AND RECEIVING SHORE RADIO STATION
"ROGERS" SYSTEM GROUND ANTENNA
TUNNEL
INSULATORS
INSULATED WIRES
RECEIVING APPARATUS INSIDE OF BOAT
SUBMARINE RECEIVING SUB-SEA WIRELESS WAVES BY THE "ROGERS" SYSTEM

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The Rogers Undersea Wireless Opens Up an Entirely New Field to Submarines and Ship Communication. Marconi Recently Stated that Submarines Had to Come to the Surface to Intercept Radio Messages, but the Rogers Invention Has Upset All This. On a Recent Test a U.S. Subsea Boat Submerged Off the American Coast to a Depth of 8 Feet and Picked Up Nauen, the German Station. At Depths of 21 Feet Stations with Wave Lengths over 12,000 Meters Were Easily Picked Up. Transmission to Submarines Has Also Been Accomplisht.

Official recognition of Mr. Rogers as the one and only original inventor of "Under-ground and Sub-sea Wireless Communication," was soon forthcoming, and here it is in brief. These two official letters of recognition of Mr. Rogers' wonderful and revolutionizing invention represent but a very small fraction of those he has received from radio engineers of high repute in all parts of the world, congratulating him on his masterly work. The Navy Department has just permitted information on the Rogers system to be given out, and how well they kept their secret during the World War, during which time this system has been in use by the Navy Department, may be judged by the fact that radio men everywhere are amazed at this feat. The distinguished radio savant Prof. George W. Pierce of Harvard University, congratulated Mr. Rogers heartily when he first tested and heard the new system work thru salt water, which he at first thought absolutely impossible.

Hyattsville, Md.,
January 13, 1919.

Dr. Nikola Tesla,
New York City, N. Y.

Dear Dr. Tesla:—

I have just read with great interest your article in the Electrical Experimenter. For years I have been a firm believer in the theory that far distant aerials were actuated thru the medium of the Earth and not thru the ether above, and it is a source of great satisfaction that so illustrious a personage as yourself has held to the same belief. I have never met a scientist who would entertain such a proposition until I demonstrated to them results described in the enclosed paper, illustrating one of the ways I have found for utilizing the energy so clearly and forcibly described by you. I am, nevertheless, confronted by some who will not give up old theories. If you would do me the great honor of writing a few lines upon the scientific feature I would deem it a great favor.

Should you chance to be in Washington at any time I will be highly gratified to have you visit my laboratory and witness the results obtained.

Very sincerely,

(Signed) J. Harris Rogers.

Below we give the two letters of official recognition by the Navy Department of Mr. Rogers' accomplishments, which are all that we have space for.

In response to an inquiry from Clarence J. Owens, director general of the Southern Commercial Congress, Admiral Griffin, U. S. N., chief of the bureau of steam engineering, wrote under date of December 27, 1918, as follows:

"In reply to your question regarding the originator of the underground radio system, you are advised that Mr. J. H. Rogers of Hyattsville, Md., was the originator of this system. There have been other claimants to methods of underground radio signalling, but none were useful, within the Navy Department's knowledge to the extent of being a valuable asset to the general scheme of radio communications. The introduction of Mr. Rogers' receiving system marked the beginning of the use of underground aërials for receiving, to great advantage over raised aërials, and has been valuable to the Navy during the war."

Rear Admiral Strother Smith, then Capt. Smith, wrote Mr. Rogers on December 7, 1917:

"It is a great pleasure to me to feel that I have been instrumental in bringing the result of your work before the Navy Department and assisting somewhat in putting it into actual practise. Out of the many thousand ideas presented you can realize that a very, very small percentage are valuable and it is worth at least a year's work to get one that I feel will give lasting benefit to the service that I take pleasure in serving."

The Navy Department Interested.

Thru Dr. George H. Lamar and Senator Blair Lee the discovery and the status of the patents were brought to the attention of Secretary Daniels of the Navy. Secretary Daniels ordered inquiry into Mr. Rogers' claims, which showed that his invention worked, and requested Secretary Lane to give special consideration to pending patent applications.

Secretary Daniels then submitted the Rogers system to Rear Admiral (then Captain) Strother Smith, who called into consultation Capt. Hoopér. These officers made a thoro study of the system and found it practicable. Capt. Hooper ordered it installed at New Orleans first and since then it has been employed at Belmar, N. J.,* and other stations.

* At the time of writing this article the Belmar Trans-Atlantic Receiving Station is still employing the Rogers underground antenna.

For a decade Mr. Rogers has been studying radio subjects, and long before the United States entered the war he had experimented with the problem of ridding aërial communication of this static atmospheric electricity. He disagreed with all authorities who believed that the air, and not the earth and water, was best suited for wireless communication.

At first Mr. Rogers used the earth alone for sending messages to amateurs stationed near by. Using an audion bulb, he then buried a wire from his laboratory and heard Philadelphia and other stations. Further experiments were conducted at a laboratory

To the American Radio Amateur:

WITHIN the next few months peace will be declared and the amateur will be allowed to operate his station as before. Thanks to Mr. James H. Rogers, it will not, however, be necesary for you to put up an aerial again—at least not for receiving. Elevated aerials will be a thing of the past, and well they may.

But ordinarily the amateur would not be permitted to use the underground aerial system on account of Mr. Rogers' fundamental patents. The writer, however, in conversation with Mr. Rogers, prevailed upon him to allow amateurs the free use of his revolutionary, as well as epoch-making invention.

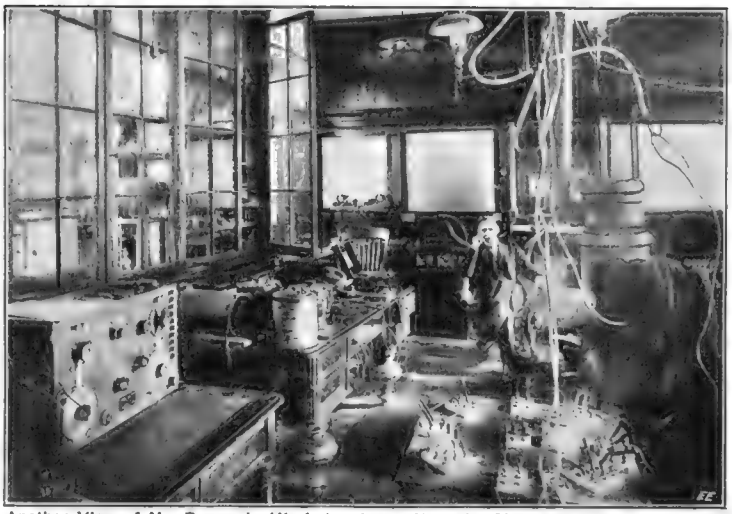
Mr. Rogers thru the ELECTRICAL EXPERIMENTER therefore wishes to announce that he personally has no objection if amateurs use his system privately. It should be understood that the inventor only gives this permission to amateurs as such, and that this permission, of course, does not extend to firms or corporations or to individuals engaged in commercial Radio work.

We wish to congratulate our readers upon this important decision of Mr. Rogers, who certainly deserves the everlasting gratitude of all American Radio Amateurs.

H. GERNSBACK.

near Bladensburg, which he calls "Mount Hooper," in honor of Commander Hooper of the Navy, who rendered excellent service in adapting the invention to the needs of the Navy Department.

When Mr. Rogers first stated that messages could be received and sent from submarines when submerged it was unanimously declared to be impossible and the officials of the Bureau of Standards were not alone in this belief, as no less a personage than Marconi declared at a banquet given in his honor in Washington, that when wireless was used on submarines, **"it was necessary for the submarine to come to the top in order to catch the ether waves."**



Another View of Mr. Rogers In His Laboratory. Note the Glass Instrument Cases, and In the Background May Be Seen His Early Printing Telegraph Model.

To demonstrate more clearly the underground system and to show how it could be used in trench warfare, Mr. Rogers constructed an underground station, wholly inclosed beneath the surface of the earth, there being no visual existence of it outside. This place in Prince Georges county was visited by some very noted men, including Dr. Abraham, the head of the French Scientific Commission, who, upon entering the cave at Mount Hooper exprest his amazement and remarked, "the Germans can't get us here." Lieutenant Paternot, of the French Scientific Commission and the radio representative of France, also heard his native stations talking and exprest equal satisfaction, pleasure and amazement.

How He Conceived the Underground System.

The writer asked Mr. Rogers just how he came to form the idea of the "Underground and Subsea Radio." He explained that from his very first study of the method of transmitting radio signals by means of an elevated antenna, the question constantly presented itself to his mind—"If 50 units of power are past into the aërial, then what becomes of the equal amount of energy which passes into the ground?" He became so obsest with this conundrum that he finally asked several prominent radio savants this question. What do you suppose the answer was?—"It is dissipated in the form of heat in the ground," they answered. But still Mr. Rogers thought they were wrong and now he has proved it. Another early idea of his in the theoretical aspect of radio-communication was as follows, and very logical it was, too, as you will agree: He held that if the outer crust of the earth is a *conductor*, and the surrounding atmospheric envelope is an *insulator*, then how infinitely better must the former be for the transmission of any form of electric current.

To Mr. Rogers' mind it was more reasonable to suppose that the energy liberated at the base of an aërial was propagated thru the earth as well as thru the ether above, and that an elevated aërial, at great distance, would be actuated by them as effectually as if the waves reached the same point thru the ether above; when the waves thru the earth reached the base of the aërial the potential of the plate would be raised and lowered and the aërial would accordingly be energized. Thus was his basic and original idea conceived and settled upon.

Mr. Rogers' first trial with the underground wireless to nearby radio amateurs began about seven years ago, but his theory of the reason why it must work was formulated over ten years ago. Further, he conjectured that much less power would be required to propagate a wave or current thru the earth's conducting crust, which for one thing has smaller geometrical dimensions, than to propagate it thru the insulating atmospheric envelope alone. See Fig. 1.

The Theory of Operation.

A number of other radical ideas were entertained for several years by Mr. Rogers, and in the course of time he has found that his ideas were correct—it worked! it worked! And now the radio experts far and wide are holding a *post mortem* inquest on their theories and how it all happened. To start with, Mr. Rogers stated, "special credit is due the following gentlemen, who have re-

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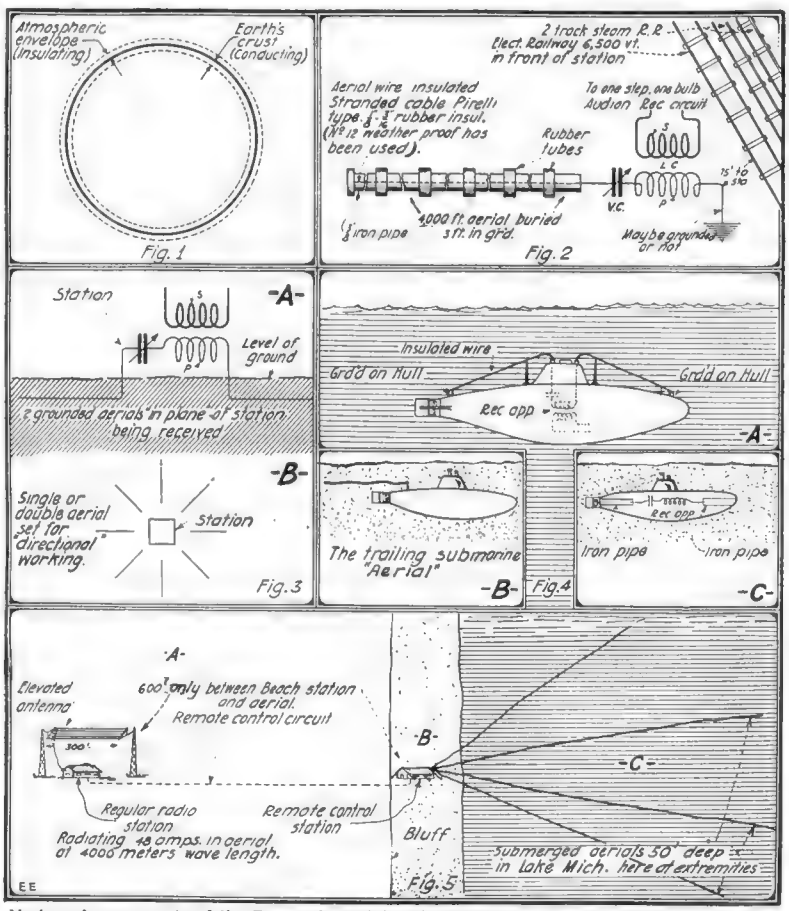


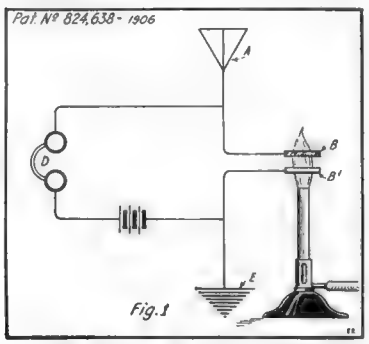
Various Arrangements of the Rogers Ground Aerial System, Including the Submarine "Underwater" Antenna.

How I Invented the Audion

By Dr. LEE de FOREST

Written exclusively for the Electrical Experimenter

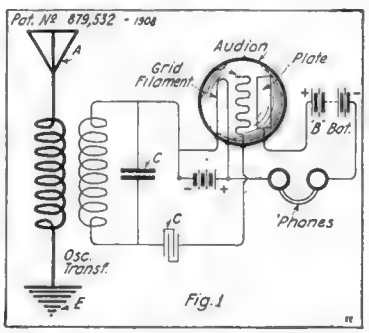
THE first conception of a detector of Hertzian waves which should employ the medium of heated electrodes or heated gas came to me as follows: In the summer of 1900 I was experimenting on a new type of electrolytic



The First Step in the Development of the Audion by Dr. Lee de Forest. The Aerial and Ground Were Connected to Two Electrodes Placed in the Flame of a Bunsen Burner, with Successful Results.

detector, doing this work at night in my room in Chicago. The receiving apparatus was placed on a table beneath a Welsbach gas burner. A spark coil which I was using as my source of oscillations was located in a closet about ten feet distant. One night I noticed that whenever I closed the switch of the spark coil by means of a string running across the floor from my table to the coil, there was a decided change in the illumination from the Welsbach burner. The light from the gas mantel increased very perceptibly and resumed its normal low brilliance as soon as the sparking ceased. This phenomena continued and imprest itself strongly upon my attention. My first thought was that I had discovered a new form of detector of Hertzian waves, of extraordinary sensitiveness, and was, naturally, much enthused, as any young investigator would have been under similar circumstances. But upon closer investigation of this novel phenomena I found that when the door of the closet was closed, or almost closed, the effect of the spark upon the gas burner ceased! This proved conclusively that I was dealing with sound waves coming upon a sensitive flame and not with electrical waves.

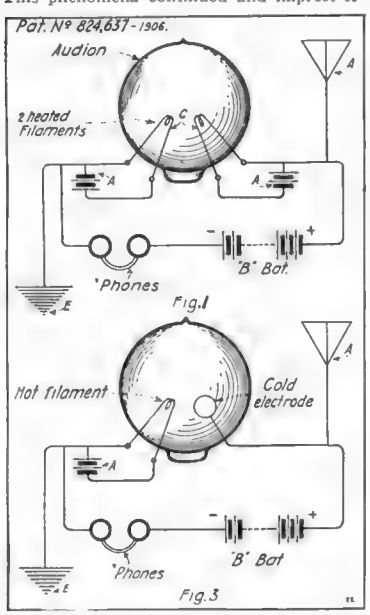
The delusion lasted, however, long enough to force upon my mind the conviction that heated gas molecules were sensitive to high frequency electrical operations, and I determined to investigate further at my first opportunity and actually discover evidence to substantiate my theory. I was unable to do this until the fall of 1902 or '03 when I returned to my gas mantel experiment. I first attempted to investigate the new detector phenomena by using two needles of steel, or platinum, placed close together in the incandescent Welsbach mantel. These



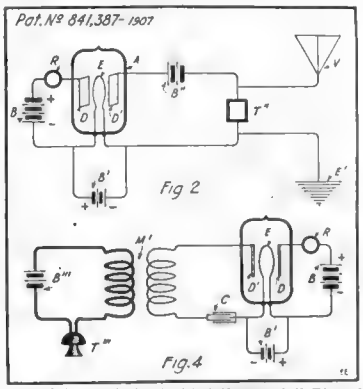
Later the "Third Electrode" Resolved Itself Into a Grid, Which Was Placed Between the Wing and Filament, Where It Could Act with the Highest Efficiency. In This Form It Has remained Practically the Same to the Present Time.

two needles were connected to a dry battery and telephone receiver. I was, however, unable to obtain any appreciable current between the two electrodes in the mantel. I then investigated the flame of a Bunsen burner and soon found a point in the outside envelope of the flame where an appreciable current did pass between the two electrodes, making a soft fluttering sound in the telephone receiver. (See Fig. 1, Patent No. 824,638, issued in 1906.) Then, connecting one electrode to an antenna and the other to the earth, I heard for the *first* time signals in the telephone receiver; signals which represented clearly the sound of the transmitting spark. Here at last was actually demonstrated my earnest belief in the existence of this new detector principle. My next step was to enrich the gas flame by putting a lump of potassium or sodium salt in the flame directly below the two platinum electrodes. This increased ionization caused increased flow of battery current, and a corresponding increase in sensitiveness of the new detector. I did considerable work then with various types of Bunsen burner arrangements for permanently enriching the gas flame, etc., and set up a laboratory type of flame detector which was actually used in 1903 for receiving signals from ships down the Harbor of New York.

The inconvenience of supplying a source of gas for the new detector was, of course, obvious, and I sought for other means of obtaining the necessary heated gas and heated electrodes. The electric arc first



Here the Placing of the Two Heated Electrodes in a Vacuum Bulb Is Carried Out, as Well as the Final Adoption of the Cold "Wing." This Device Works Equally Well with Both Electrodes Hot, Thus Disproving Any "Rectification" Theory.



Here We Find the "Third Electrode" Placed Inside the Bulb, Where It Logically Belonged, as Dr. de Forest Points Out. Fig. 4 Shows the First Use of the "Stopping" Condenser.

suggested itself. I anticipated that while this arc would be a detector, it would be exceedingly irregular and noisy in the telephone receiver. This was found to be the fact. The battery fed the arc thru the primary of the transformer, in the secondary of which was connected the telephone receiver, and, altho at times the looked for response to electric waves was thus obtained, the noise in the telephone receiver from the arc was so deafening that the idea was abandoned.

The next plan which suggested itself to me was to use incandescent filaments in an enclosed chamber. This arrangement as well as the gas detector, was illustrated in my patent No. 979,275, which bears the first date of November 4, 1904. This patent ap-

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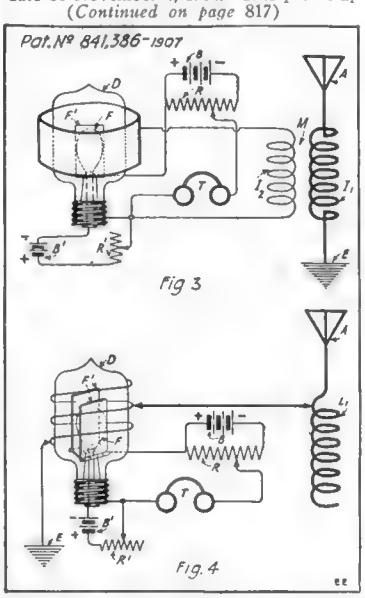
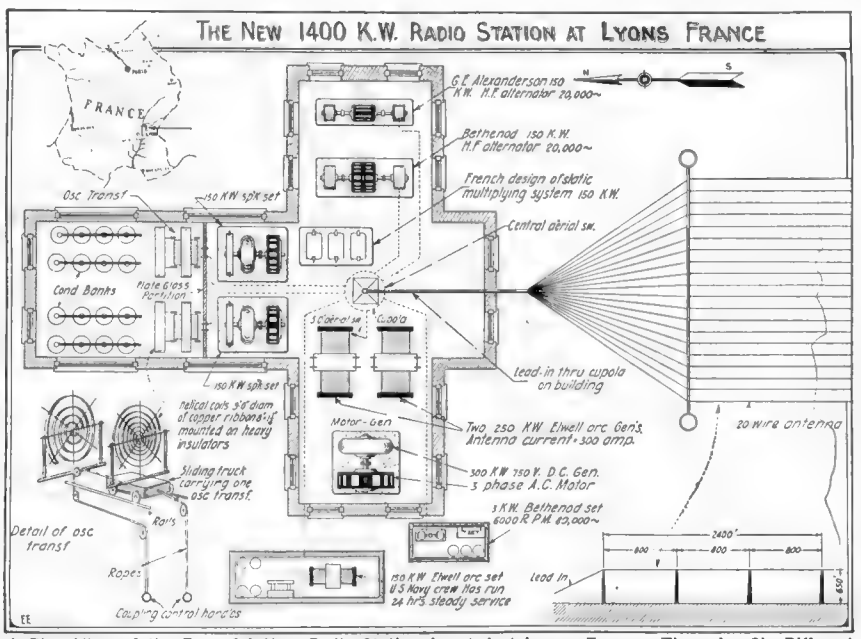


The First "Three Electrode" Audion Had a Piece of Tinfoil Wrapt Around the Outside of the Bulb—a Principle Frequently "Rediscovered," as Was the de Forest Electromagnetic or Coil Electrode, Fig. 4.

Gigantic 1,400 K.W. Radio Station at Lyons, France

ONE of the most powerful wireless stations yet designed is that now nearing completion at Lyons, France, and we are indebted for the following description of this remarkable and extremely high power radio station, representing the very latest advances in radio engineering, to Dr. Lee de Forest, the well-known American radio engineer and scientist who has recently returned from a trip thru Europe. Dr. de Forest stated that apparently no expense was being spared in the design and construction of this now famous Lyons station, and that the engineers were apparently having everything *carte blanche*, for there seems to be no limit to the apparatus installed, and in contemplation for installment at this powerful station.

A glance at the map shows that Lyons lies southeast of Paris, and about half way between Paris and Marseilles. This station has been, and is at the present time, handling all of the official Government radio traffic to the United States, communicating principally with the powerful new naval radio station at Annapolis near Washington, D. C. The Lyons station is in daily communication, and has been in connection with various parts of the Continent, as well as Africa, different countries of Asia, and many other far-flung places in all parts of the globe.


THE NEW 1400 K.W. RADIO STATION AT LYONS FRANCE
FRANCE
G.E. Alexanderson 150 K.W. H.F. alternator 20,000~
Bethenod 150 K.W. H.F. alternator 20,000~
French design of static multiplying system 150 K.W.
Central aerial sw.
Osc. Transf
150 K.W. spk. set
Cond. Banks
Plate glass partition
Control sw.
Cupola
Lead-in thru cupola on building
150 K.W. spk. set
Helical coils 9'6" diam. of copper ribbon 3" mounted on heavy insulators
Motor-Gen.
Two 250 K.W. Elwell arc Gens. Antenna current 500 amp.
20 wire antenna
Sliding truck carrying one osc. transf.
500 K.W. 750 V. D.C. Gen. 3 phase A.C. Motor
3 K.W. Bethenod set 6000 R.P.M. 20,000~
Detail of osc. transf.
Rails
Ropes
Coupling control handles
150 K.W. Elwell arc set 3 Navy crew has run 24 hrs steady service
Lead in
2400'
800
400
800
650'
N
S
E

A Plan View of the Powerful New Radio Station Located at Lyons, France. There Are Six Different and Distinct Forms of Transmitters Installed in Duplicate as Shown. The "Receiving Rooms" Are in a Wing of the Building, Not Shown Here, Running Eastward from the Point Where the 150 K. W. Spark Sets Are Situated. This Wing Includes a Laboratory, Tape Punching Room, Quarters for the Personnel and Administration Office.

At first this may sound somewhat exaggerated, but when the great capacity of this radio station and the extremely efficient apparatus used is considered, it will seem all the more reasonable and possible. To begin with, the Lyons station has a very large aërial, comprising twenty strands of phosphor-bronze cable stretching away over a distance of 2,400 feet and supported on eight steel masts, each of which rises to a height of 650 feet. The masts are placed about 800 feet apart. It is interesting to note in this connection, as Dr. de Forest pointed out, that the engineers responsible for the design of this station have found that contrary to the generally accepted idea concerning the directive effect of inverted "L" aërials of this type, that where great distances and long waves are concerned, the comparative efficiency of transmission in any certain direction about the antenna does not differ appreciably. The general direction of the present antenna is north and south, as the arrow shown in the plan view of the station indicates, the free end of the huge antenna pointing toward the south.

The aërial conductors at the station end are fan-tailed together as shown and a large twisted cable forming the lead-in, leads down thru a cupola on top of the building, underneath which there is a large and very elaborate circular antenna switch from which lead separate connecting aërial wires to the various transmitting apparatus, several distinct types of which are installed in this station.

The lay-out of the station buildings has been well planned, and the larger building, containing all of the long distance radio transmitting equipment, is in the form of a cross. West of the large building there are two small structures, a small one containing a 3-K.W. high-frequency generator of the Bethenod (French) type, having a speed of 6,000 r.p.m. operating at an antenna frequency of 80,000 cycles. The building next to this houses a 150-K.W. arc generator of the Elwell type, and this transmitting set has an antenna lead running to the central aërial switch in the main station building. This particular set is of great interest to Americans, as it is the one which has been used in transmitting all of the official Government messages to the United States. It has been operated right along with a United States naval radio crew, and has been very busy night and day. The powerful arc-oscillation generator has been in use continuously, and has often been run *twenty-four hours at a stretch*, only shutting down the arc periodically for renewing the electrodes.

The following description of the main station transmitting equipment, which is being installed in duplicate, is given in the order of its installation, the first apparatus described being the older.

In the long northerly wing of the station of the main building there are installed two 150-K.W. spark sets. These are somewhat similar in design to the well-known Fessenden spark transmitter at Arlington near Washington, D. C., and those who are familiar with that station and the huge condenser and tuning transformer dimensions and equipment there used, will have some idea of what this apparatus looks like. The high tension leads from the step-up transformers, pass thru large plate-glass partitions to the condenser and oscillation transformer room. The condensers are placed in banks and provided with necessary switches, busbars, etc., for connecting them up in series, parallel or in series-parallel, as may be necessary. The oscillation transformers are very interesting as they are huge affairs, each spiral being composed of many turns of heavy copper strip, the dimensions of the strip being 8 *inches wide by ¼ inch thick*. The convolutions of the helix in each case are well supported and installed on large porcelain insulators, and one of the coils on each transformer unit is made movable for adjusting the coupling, or distance between primary and secondary, in the manner here illustrated. As will be seen, the movable primary coil is placed on a small truck mounted on four wheels, which rest on a pair of insulated tracks. The coupling is changed whenever desired, by simply pulling on one or the other of two ropes attached to the carriage in the manner indicated. When a change in inductance is to be made in one of these oscillation transformer windings, it is accomplished by changing the position of one of the lead cables connected to the spirals, the end of the cable being fitted with massive clamps, which may be fastened at any point desired on the spiral.

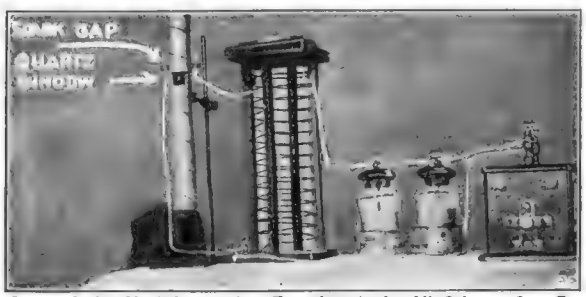
The eastern wing of the main station will shortly contain two radio frequency alternators, as the plan view shows, one of these being of the General Electric-Alexanderson design, rated at 150 K.W., and the other set being of the Bethenod (French) design, rated at 150 K.W. also. These sets are tuned and adjusted to operate at an antenna frequency of 20,000 cycles. By means of the cleverly arranged antenna switch-gear, either of these sets can be connected up to the antenna. Also, when necessary, two such sets may be connected in parallel to the antenna for extra long range

(*Continued on page* 817)

Experiments With Ultra-Violet Light

By J. C. MORRIS, Jr.

ALTHO the majority of experimenters are interested in the subject of X-Rays, little attention has been given to the study of the *ultra-violet rays*. These rays have been extensively studied by Finsen and other investigators and were found to have a wave length of about .0002 mm. This is far too short a wave to be seen by the human eye, but their production is usually accompanied by manifestations of visible light.



Some of the Most Interesting Experiments In All Science Can Be Conducted with Ultra-Violet Light. The Simple Apparatus Required for Producing These Rays In Quantity Is Illustrated and Described Herewith. Ultra-violet Rays Will Solve Some of the Great Problems of the Future.

All of the apparatus required to produce these rays is extremely simple and is to be found in nearly every experimenter's workshop. Fig. 1 shows how the apparatus is connected: C, is an induction coil giving a spark 1 inch or more in length; L, is a Leyden jar or other form of high voltage condenser; H, is a coil consisting of 10 or more turns of heavy wire (a good wireless helix will do very well) and G, is the generator of the *ultra-violet rays*. It consists of a spark gap whose terminals are composed of iron or steel nails. A convenient form of generator may be made out of a short length of card-board tubing, thru which the nails are driven. A gap of ⅛ inch must be left between the nails. A small opening must be cut in the tube for the rays to pass thru. A quartz (not glass) window may be placed in the opening, if desired. See photograph. A small spark gap may be placed at X, if desired.

The following are some simple experiments with the *ultra-violet rays*.

Experiment No. 1:—Secure if possible a piece of willemite (which is a natural silicat of zinc). When the willemite is exposed to the ultra-violet rays it will fluoresce with a pale greenish color. This is a test for these rays.

Several other substances besides willemite will fluoresce when exposed to these rays, among these are sodium silicat, fluorescin, aesculin, sulfate of quinin, also platino—barium-cyanid screens, such as are used for X-Ray purposes.

Experiment No. 2:—One of the most peculiar properties of the ultra-violet rays is their ability to ionize air; that is, to make air a partial conductor of electricity. The following three experiments demonstrate this property of these rays.

Make two disks of metal about 5 inches in diameter. Place one of these on top of an electroscope. Suspend the other about ½ inch above the electroscope. Now charge the electroscope with either positive or negative electricity. Focus the ultra-violet rays between the plates. The electroscope will soon be discharged, due to the ionizing (rendering conductive) effects of these rays.

Experiment No. 3:—Start a small induction coil and separate the secondary terminals just beyond the sparking distance. Focus the ultra-violet rays on the spark gap. The spark will now jump the gap, due to the ionizing effects of these rays.

Experiment No. 4:—Take two small metal sheets and separate them a short distance apart. Connect these plates in series with a powerful high voltage battery and a very sensitive galvanometer or telephone receiver. No current now flows, due to the resistance of the air gap. Focus the rays between the plates and a minute current will now flow, due to the ionizing effects of these rays.

Experiment No. 5:—Start the generator of the ultra-violet rays. Place a piece of glass in front of the opening and examine a piece of willemite. It does not fluoresce. Substitute a piece of quartz or of ice in the place of the glass. The piece of willemite will now fluoresce. This experiment shows that *glass is opaque to these rays,* while quartz and ice are transparent to them.

Experiment No. 6:—There are certain substances which are able to transform the short ultra-violet rays into visible rays of light. A Geissler tube is a generator of these rays and may be used to show the fluorescence of certain substances. Make a fairly dilute solution of sulfate of quinin, and add a few drops of sulfuric acid. Partially immerse a Geissler tube into the solution and connect with an induction coil or preferably to the positive pole of a static machine. While the tube is being operated the solution will appear to be light blue in color.

Other substances besides quinin will fluoresce. Some of these are aesculin (from horse chestnut bark), fluorescin, and hydroquinon, such as used in photography.

These are only a few of the many interesting experiments which can be performed with these rays. The photograph is a picture of the author's apparatus for generating these rays. The study of the ultra-violet rays is exceedingly interesting and will amply repay the time spent in making the apparatus. It represents an uncommon field for experiment and one that holds much promise for the future of science.

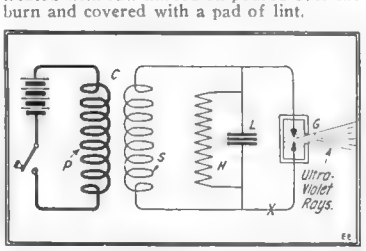
WORKSHOP ACCIDENTS.

It is well to know what steps should be taken in the case of the minor accidents that may happen to handicraftsmen and experimenters in the prosecution of their hobbies. These are mostly in the nature of cuts, scalds, and bruises. It is a good plan to keep a lump of alum handy to stop the bleeding in the case of small cuts. Toilet alum, sold by druggists, is the best, and is frequently used by those who shave themselves.

A simple clean-cut wound should be cleansed in cold water under the tap, which generally stops the bleeding at the same time, after which the sides should be brought together carefully and supported by strips of sticking plaster held in position by a bandage.

Wounds inflicted by rusty nails and other pieces of metal often lead to serious inflammation or blood-poisoning. These ill effects may be prevented by the following very simple remedy. Place a little brown sugar on a fire shovel and heat until it smokes, holding the wound in fumes for several minutes. A few scraps of clean woolen rag will answer the same purpose, but sugar is best. Peroxid of hydrogen and iodin tincture are reliable solutions for treating wounds which involve abrasions.

Some boracic ointment should always be kept available in case of burns and scalds resulting in a raw surface, or a strong solution of washing soda may be used. Severe burns, and in particular those caused by splashes of molten metal, are best treated with raw linseed oil poured over the burn and covered with a pad of lint.



Hook-up of Spark Coil, Condenser, Inductance and Spark Gap for Producing Powerful Ultra-violet Rays.—Fig. 1.

Small splinters of steel or wood are often run into the flesh and cannot be removed with the fingers alone. In the absence of a pair of fine pointed tweezers an ordinary sewing needle may be employed. Heat the end of the needle, or dip it in peroxid of hydrogen, iodin, or carbolic acid and water, to kill any germs on it before touching open cut. Slip the eye of the needle over the protruding end of the splinter, give it a twist to make it grip, and then raise the needle when the splinter will come out as well in most cases.

Contributed by H. J. GRAY.

Wood Finishing for the Amateur

By ARNO A. KLUGE

WHEN the experimenter is constructing a piece of apparatus, whether it be an instrument cabinet or one of Tom Reed's famous clocks, he is confronted with the problem of finishing the woodwork on it, if such there be. We often find that this last process is neglected to a degree where it is a detriment to the appearance of the instrument, and as "looks is everything" to the uninitiated, we should give the matter a little more time and study.

There are a number of general processes used in finishing a piece of wood, namely: Sandpapering, Staining, Filling, Shellacking, Varnishing, Rubbing, and Polishing, in the order in which they occur. Each of these will be treated separately, also any subdivisions which may come under them; but we should bear in mind that it is not always necessary to use all of them, and so the finisher should know the exact processes he is going to use before starting any piece of work. Also, all of the material required should be at hand, so that the work may proceed expeditiously and without waste of time.

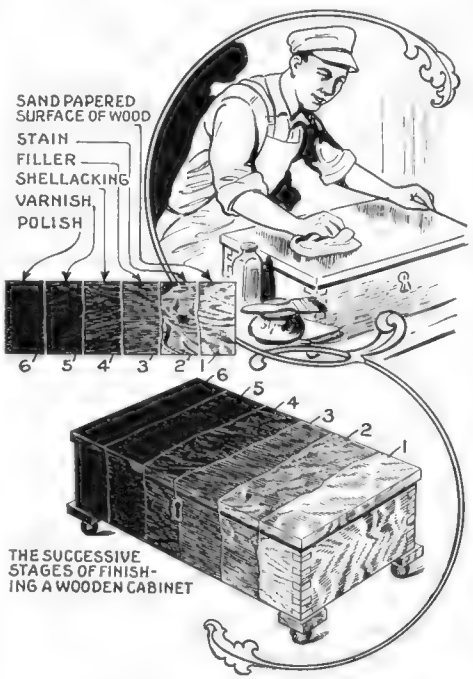
The first operation, that of sandpapering is to give the wood an absolutely smooth surface and prepare it for the filling. It is assumed, of course, that the wood has already been planed reasonably smooth, so that No. 0 sandpaper is about right for the job. A sandpaper block about four inches square and one inch thick should be prepared, taking care that one of the four-inch surfaces is perfectly flat, with no high corners. The piece of sandpaper is placed underneath the block, the surplus sides turned up, and the sandpapering done ACROSS the grain. Never sandpaper with the grain, as this produces tiny grooves on the surface, especially with soft woods.

One other precaution should be noted. Be careful when sandpapering close to the edges, they will be rounded off if you bear down too hard. If desired, a piece of scrap wood whose surface is flush with the work may be laid up against the edge, so that the sandpaper will pass over to this piece when it reaches the edge of the work. After these operations are completed, dusting off is in order, and it should be done thoroly, to remove every particle of dirt from the surface.

We are next ready for staining the wood, if we desire to change its color in any way. Remember, however, that staining is only resorted to when we do not wish to finish it in its natural state, but have decided either to emphasize its own color, or give it another in imitation of some other wood. Most hard woods are more beautiful in their own color than they are in a false dress.

There are two kinds of stains in common use, and both have their faults and good points. These are: Oil stains, in which the pigments are reduced to a workable consistency by the use of turpentine, naphtha, etc.; and water stains, which, as indicated by the name, use water in preparation, and hence must use water-soluble pigments. The main advantage of the oil stains is that they do not raise the grain of the wood, and do not show the laps of the brush strokes upon soft, open grained woods such as white pine, poplar, etc. Upon hard woods, however, they do not penetrate deep enough to be desirable, and water stains are commonly used for such.

Water stains are very penetrating, and if properly made will bring out the grain of the wood very beautifully, instead of clouding it as most oil stains do. Their chief fault lies in the fact that they raise the grain, involving additional sandpapering to obtain a level surface, but this is offset by the additional beauty of the finished product.



This Illustration Shows Clearly the Successive Stages to Be Carried Out in Polishing a Wooden Cabinet. It Must Be Thoroly Sandpapered or Else the Much Desired High Polish Will Be Hard to Attain.

In addition to the two classes of stains just mentioned there are the aniline stains which have practically supplanted all the others. When buying colors for the aniline stains, it is necessary to name the color, as aniline black, aniline red, or whatever it may be. Some good formulas for each class of stains are given herewith, these having been compiled by a cabinet maker of many years' experience, and their accuracy can be vouched for. Ready-made stains can be bought almost as cheaply, however, and if time is an asset, these are advisable.

Mahogany. Boil logwood chips in a closed vessel with twice their bulk of water for several hours; strain, and add a small quantity of chlorid of tin to give it redness. Two coats are necessary.

Walnut. Permanganat of Potash.....1 ounce
Epsom Salt .....1 ounce
Water .....1 quart
Dissolve, strain, and apply several coats.

Cherry. Reduce the mahogany stain for cherry.

Oak. Asphaltum Gum.....¼ pound
Turpentine ..... 1 pint

Ebony. Dissolve extract of logwood in wood alcohol to the strength desired, strain, and apply. Develop the color by going over the work with a solution of muriat of iron, made by mixing equal parts of it and alcohol.

Yellow. Turmeric Powder .....1 ounce
Alcohol .....1 pint
Allow this to stand several days, shaking it often. Strain for use, applying several coats.

Aniline Mahogany. Bismark brown.....1 ounce
Water .....3 quarts
The above formula is typical of all aniline stains.

Antique Oak. Dissolve asphaltum in naphtha, making a very thin mixture; the filler used should be the antique filler.

The third step is filling the wood, if staining has been necessary, and by this we endeavor to level up the surface, and get a mirror-like smoothness. It is best to purchase fillers ready-made, as it is difficult to get the proper consistency. They consist of very fine silex stone, in a mixture of half linseed oil and half turpentine, with the proper coloring matter added. After the filler has been applied, and its color begins to change to a dull flat appearance, it is time to rub it off, using a piece of flax or hemp tow for the purpose, and rubbing until the surface is quite smooth. the work should not be allowed to dry thoroly.

After filling, shellacking is resorted to with hardwoods, in order to close up the pores completely, and prevent the sinking in of the varnish, which would otherwise leave tiny pinholes on the varnished surface. Pure grain alcohol shellac, either the orange or the white, should be used, mixed in the following proportions:

Shellac .....½ pound
Grain or wood alcohol..... 1 pint

After allowing the shellac to dry for six or eight hours, sandpaper with No. 00 sandpaper, being careful of the corners, and also to use but little pressure, so as not to cut thru the coat of shellac. With new sandpaper it is best to rub two pieces together several times to remove the danger of scratching.

When applying varnishes a brush suited to the size of the work should be used, and the operation should be performed in a room temperature of at least 70°, to insure free flowing. Altho it is impossible to tell just how to varnish successfully, practise being the only way to learn, a few simple rules may be given. Apply the varnish with the flat of the brush, along the grain; then rub it out crossways to get an even application; finally finish it off with the grain. Care should be taken not to skimp on varnish, and yet at the same time not to put too much on. This is another matter where practise is the only real teacher.

After one coat of varnish has been applied and is thoroly dry, the surface is rubbed smooth, using ground pumice stone and a pad of rubbing felt. The finer grades of pumice stone, as F and FF, are the best, as there is less danger of scratching thru the varnish. One should always rub with the grain and not bear down too hard at the beginning or end of the strokes. Some linseed oil should be at hand as rubbing oil, the felt being dipt into the oil and then into the pumice stone, a quantity of the latter thus adhering to the felt. Cleaning off should be done at once, using soft cotton waste for this purpose. Woods having coarse fibers should not be rubbed until two or more coats of varnish have been applied, waiting, each time until the previous coat is dry. This is necessary or the fibers will come up above the surface, thru the varnish.

Having rubbed the surface perfectly smooth we may now give it a high polish, or we may leave it with a "dead" finish. If polishing is elected we may proceed in

(*Continued on page* 810)

Experimental Chemistry

By ALBERT W. WILSDON

Thirty-Fourth Lesson

SILICON

SILICON is the central element in the mineral world, like carbon is in the animal and vegetable kingdom. Unlike carbon, silicon never occurs in the free state. Next to oxygen, it is the most abundant element. Oxygen is estimated to make up nearly half of the solid crust of the earth, and silicon to constitute about a third more. Its occurrence is chiefly

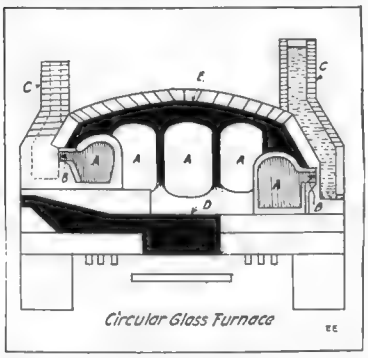


Fig. 160. A Circular Glass Furnace: A—Fire Clay Pots. B—Openings for Introducing Blowpipe. C—Chimney. D—Source of Heat. E—Roof, from Which Heat Is Reflected Downward.

in combination with oxygen in quartz and silicon dioxid (SiO_2). This non-metallic oxid is often further united with some metallic oxid, such as aluminum oxid (Al_2O_3) to form a silicate. It is, further, the chief constituent of nearly all rocks, and consequently, also of the soils which have resulted from the decomposition of rocks. It is also found in ashes of many plants, having assisted to make up their mineral structure. Despite the fact that this element is so widely distributed, the element itself has been, until recently, separated from its compounds only with such great difficulty that it was only a curiosity. By the present methods of reduction it is no longer difficult.

History.

Amorphous silicon was first separated and isolated in 1810 by Berzelius in an impure form. Later, in 1823, he obtained the pure element, by fusing together iron, carbon, and silica (Silicon Dioxid SiO_2). Deville prepared the crystalline variety in 1854. Phipson in 1864 first reduced it by magnesium.

Occurrence.

As previously stated, the element does not occur in the free state. Its affinity for oxygen is so great at a high temperature that in early ages, when the earth was a molten mass, the silicon all combined with oxygen to form silicon dioxid (Silica SiO_2), this later uniting with metallic oxides to form silicates.

Preparation.

Amorphous Silicon is best prepared by mixing equal parts of powdered and well-dried white sand (SiO_2) and magnesium. This mixture is placed in a test tube and heated with a Bunsen flame. The reaction soon begins with a glowing which rapidly extends thruout the entire mixture.

$$Si\ O_2 + 2\ Mg = Si + 2\ Mg\ O.$$

The cooled, hardened product is powdered and then washed with dilute Hydrochloric Acid to remove the magnesium oxid. The product thus obtained is an amorphous, brown powder, which, when heated in air ignites and burns with the formation of the dioxid SiO_2.

Silicon is insoluble in water and acids, except hydrofluoric, which dissolves it readily.

The crystalline variety is prepared by fusing sodium silico-fluorid with aluminum, or zinc and sodium:

$$Na_2\ Si\ F_6 + 4\ Na = 4\ Na\ F + Si$$

The liberated silicon dissolves in the fused metal and on cooling crystallizes. The crystals are separated from the mass by treating successively with hydrochloric, boiling nitric, and hydrofluoric acids. Crystallized silicon is also prepared in an electric resistance furnace from pure silica sand and finely pulverized foundry coke.

$$Si\ O_2 + 2\ C = Si + 2\ CO$$

Properties.

The silicon of the silico-fluoric process is in the form of dark, octahedral crystals, possessing a degree of hardness, sufficient to scratch glass. They withstand white heat without igniting and resist the action of all acids except a mixture of hydrofluoric and nitric, which, when hot, dissolves them slowly.

The silicon product of the electric furnace is in the form of crystalline masses of a dark silver lustre. It is quite brittle and melts at 1420°C.

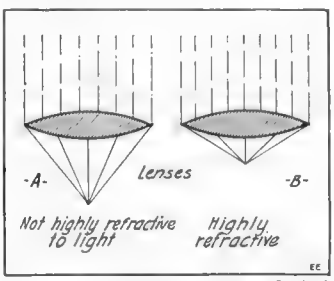


Fig. 161. Illustrating Various Optical Properties of Glass.

Glass.

What a common substance! Among the many necessities of daily life, few manufactured articles are more important than glass. The importance of this substance will be brought home forcibly when we only mention that without it the sciences of Chemistry and Physics and all branches utilizing the microscope and telescope (see Fig. 161) would probably never have been advanced to their present elevation. Bacteriology and its allied studies would have been unexplored, and as a result the lives of many who have been cured by microscopic examinations and subsequent proper treatment would have been sacrificed. Aside from the fact that it is an everyday necessity, being employed among other equally important uses, as a container for the milk which is delivered in the morning, the glasses used for drinking purposes; in rural districts as chimneys for lamps; and in large cities and dwellings for electric lamp and gas lighting. It would tax the reader too much to even for a moment try to imagine what kind of an existence we would have without our glass windows. It would mean that we would have no use for clocks, as our time would be controlled solely by the sun and moon. Imagine if you can such a superstructure as the Woolworth Building, as well as many others, practically a city in itself without windows. It is true that there may have been substitutes, but it is hard to conceive of anything which would compare with glass.

What is this substance which we could hardly do without? Generally speaking, it is an amorphous mixture of the silicates of calcium or lead with those of an alkali (Potassium or Sodium), obtained by fusing sand (Silicon Dioxid), lime or lead oxid with sodium or potassium carbonat. The cheaper grade of glass contains instead of the alkali carbonats a mixture of either one of the sulfates and coal dust. Thus the sulfates are reduced to sulfids, which form silicates with the sand. Upon the composition depends the degree of fusibility, hardness and refractive powers of the glass. Thus we must distinguish between the varied kinds.

Lime (Plate) Glass: This grade is much cheaper, harder and *less* fusible than "lead" glass. It is either a soda or potash-lime glass. The *soda-lime* glass, which is readily fusible, is the commoner sort, such as is used where cheapness is desirable, such as is used for window glass, plate glass, bottles, etc. The *potash-glass*, also known as Bohemian and Crown glass, is a silicate of lime and potassium. This kind fuses only at a high temperature, and is harder, and withstands the action of water and acids better than soda-glass. For this reason it is used extensively for the manufacture of chemical glassware, which must withstand fairly high temperatures without fusing. Potash glass is used for Leyden jars.

Lead (Flint or Crystal) Glass: Litharge (PbO) or red lead replaces the calcium oxid of lime glass. This kind is used for cut-ware, optical glass, such as lenses and prisms, being heavy, possessing great luster and brilliancy.

Replacement of a portion of the lead oxid by thallium oxid or boron tri-oxid, causes the refractive property of the glass to be increased considerably. The boron glass is called *"strass"* and finds use in the manufacture of imitation gems.

The varied colors of glass are obtained by the addition of various metallic oxids or salts. *Blue* glass is made with cobaltic oxid or cupric oxid; *Violet* glass, by using manganese dioxid; *Red* by metallic copper

(*Continued on page* 831)

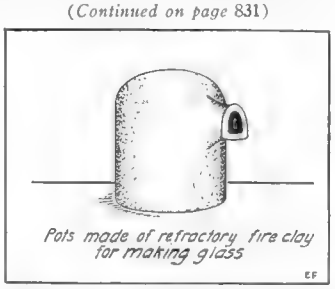


Fig. 159. The Ingredients Used In Making Glass Are Placed In Refractory Fire Clay Pots Such as This, and Then Melted at a Great Heat In a Furnace.

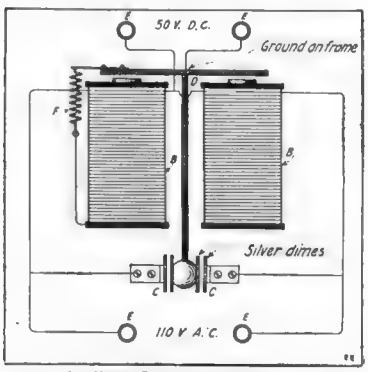
This department will award the following monthly prizes: First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.
The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of $3.00 is awarded; for the second best idea a $2.00 prize, and for the third best prize of $1.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

SECOND PRIZE, $2.00

SIMPLE RECTIFIER MADE FROM POLARIZED RINGER.

The materials required are: a low-resistance polarized telephone bell, two pair of binding posts, preferably rubber-covered, about 3" of ¼" x 1/16" brass or copper strip, and a plain wooden base, 4" x 3". and two silver dimes.

Remove the gongs from the bell and mount it on the base by means of two oblong blocks of wood, to the ends of which are screwed the attachment lugs on the bell; the blocks in turn being screwed to the base. Bend up 1" of each brass strip. To the upper portion solder half of a dime, previously filed to a smooth surface. Solder the other two halves of the dimes onto opposite sides of the hammer; see sketch for arrangement of parts. These two strips must be held down to the base by a pair of small screws. The two pairs of binding posts should be placed at opposite ends of the base. Connect as in wiring diagram.



Simple Rectifier Constructed From Polarized Ringer.

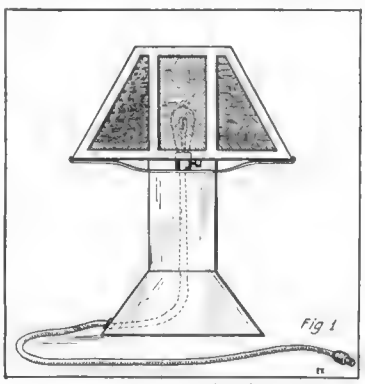
This rectifier will only handle currents from 1 to 9 amperes without dangerously overheating and operates best on 25 cycle frequency. Connect the terminals leading from the coils directly to the 110 volt A. C. current; direct current at about 50 volts D. C. will be obtained at the other terminals, due to auto-transformer action and drop due to resistance of contacts. Lubricate the armature pivots.

Contributed by GEORGE LUNGE.

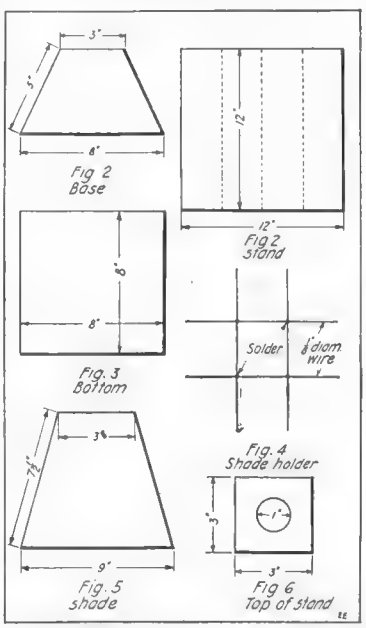
FIRST PRIZE, $3.00

HOW TO MAKE A TABLE LAMP FROM SHEET METAL.

Cut four pieces of sheet iron, brass or copper, as per Fig. 1, solder together and then cut one piece as in Fig. 3, and fasten to this. Then cut one piece like figure 2, and bend as on dotted lines, making a stand three inches square and twelve inches high. Put this thru the opening in the completed base until it strikes bottom, then solder securely; cut a hole for the cord about one inch from the top of the base. Next cut one piece (Fig. 6) for socket and solder socket base securely to this, then wire up, putting wire thru base and soldering top on. For the shade holder cut four pieces of ⅛" iron or brass wire and solder as in Fig. 4. For the shade cut four



The Finished Table Lamp.



It is a Simple Job to Cut Out the Parts for Making the Table Lamp Here Shown. Copper or Brass Gives a Fine Finish.

pieces (Fig. 5) and solder; then fasten to holder. You can glue a piece of felt on the bottom of lamp. A ten-cent can of Mission Green enamel will make an attractive color for the lamp, if it is to be used in the den.

The shade may be made quite artistic at small expense by cutting out the side of the shade in some such pattern as shown. These are backed up by pieces of ground glass cut after the pattern of Fig. 5, or figured glass may be purchased reasonably at any fixture shop. If made of brass the lamp may be polished and lacquered or given an oxidized copper finish. Such a lamp will prove very useful in the camp and bungalow.

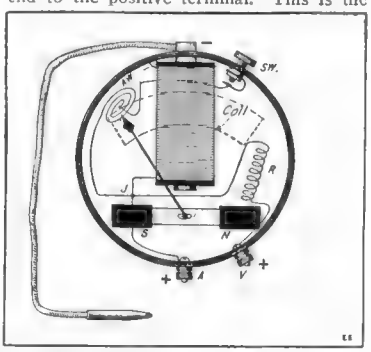
Contributed by M. F. HOLMES.

THIRD PRIZE, $1.00

HOW TO MAKE A COMBINATION VOLT AND AMMETER.

A combination meter can be made from a burned out or otherwise damaged winding of a volt or ammeter of the permanent-magnet pocket type.

Remove the old winding and rewind with No. 26 silk covered or enameled magnet wire, fastening the negative end to the shell or negative terminal, and the other end to the positive terminal. This is the



Details are Here Given for Building a Combination Volt-Ammeter From a Pocket Style Volt Meter or Battery Gage.

weak current reading, such as for old cells, coils, etc.

The volt reading is obtained by connecting a resistance (R) of varied size at J, and terminal V, which is tested by a dry cell reading approximately 1½ volts.

The amperes are now read by connecting a piece of No. 22 or 24 copper wire (A.W.) in shunt with the coil at J and a suitable switch, SW, to the case. The proper length may be found by testing with a cell of known amperage.

Contributed by L. W. CAMERON.

AUTHORS!!!

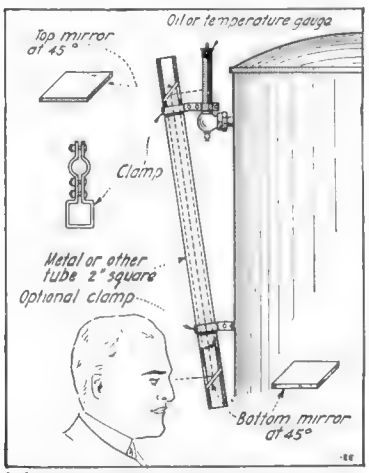
All matter intended for publication—not only by us, but by any other magazine or newspaper as well—should be written on one side of the paper only and in ink. If it isn't, somebody else must copy part of it off on another sheet before it is given to the printer.

Wrinkles, Recipes, Formulas

EDITED BY S. GERNSBACK

HOME-MADE PERISCOPE FOR READING TEMPERATURES AND OIL GAUGES.

The submarine commander has found the periscope invaluable for readily locating enemy vessels and obtaining his bearings under war-time conditions, and any electrician or engine room attendant, who has once used one of these home-made periscopes for reading meters, oil gauges or thermometers in inaccessible places, will never be without one. To make one of these periscopes, procure a piece of round or square metal tubing about two inches across. The tube may be of any length desired. Two small mirrors of suitable size are procured at a ten-cent store, and these are placed at an angle of 45 degrees, one at the bottom of the tube and the other at the top of the tube, in the manner shown. The image of the scale is reflected in the top mirror, thence down the tube onto the face of the lower mirror, and then out thru the opening in the tube to the eye. In some cases, these meter-reading periscopes are fitted with flashlight bulb at the top and a push button and battery on the base of the tube suitably secured in place, in order that the gauge may be illuminated.



A Peacetime Periscope to Make Reading of Scales Easy in Inaccessible Places.

MAKING FLEXIBLE-CORD COVERS.

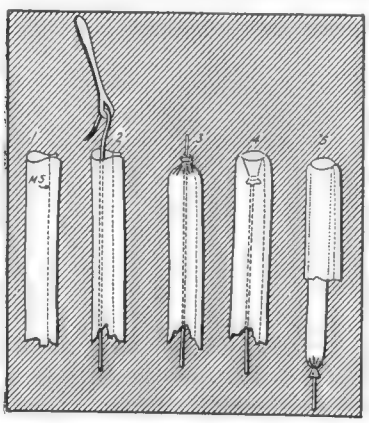
Cut a strip of cloth, any kind and any length, half an inch wide, fold it lengthwise as in Fig. 1, with the *wrong* side out if there is a wrong side, and sew a line of machine stitch down the side as shown. Don't try to sew too near the edge.

Next, run a piece of stout twine thru with a tape needle, as shown in Fig. 2. When thru, gather the upper edge of your cloth tube together, as in Fig. 3, and *sew* it to the piece of twine. Don't try to tie your twine, as that makes rather too large a knot to start thru easily.

Now hold the other end of the twine in one hand (or if your tube is very long, tie it to a door-knob) and with the other hand work the puckered end down inside, with a motion like pulling on a glove-finger, (Fig. 4). Once started, there is not the slightest difficulty.

Fig. 5 shows the end of the operation, with the completed tube coming thru, right side out, with the seam concealed, and with the extra flap serving to stuff the tube and make it plump and round. The conductor, composed of a dozen braided wires from your old Ford secondary, is run thru with the tape needle, and there you are. Cost per yard, exactly $0.00.

I have a particular affection for this invention because I had a dollar on it once —about the only dollar I ever did wring from Science. The stenographer was aiming to replace a broken belt-loop on her velvet coat, and was stumped to know how the tailor had got the seam inside. Recognizing my old process, I was explaining it to her, when the boss came in and bet me a dollar I couldn't do it. The girl made the tube, I ran the string, manipulated a second, and "Psst!" thru it went, like a rat two jumps ahead of the feline. The boss handed over his dollar, while the stenographer said something which in polite ladies' language is equivalent to—"Well, I'll be d——d!"



Psst! An Alcove Secret! Our Friend Reed Tells Us How the Tailors Got the Seam Inside.

Contributed by THOMAS REED.

ANOTHER STORM GLASS OR BAROSCOPE.

Potassium nitrat.....	Gr. 30
Ammonium chlorid.....	Gr. 36
Absolute alcohol.....	Fl. Dr. 6
Alcohol	Fl. Dr. 6

Put the mixture into a bottle 18 inches in length and ¾ inch in diameter, and cover the mouth with a piece of perforated plaster.

If the weather is to be fair the insoluble matter will settle at the bottom of the tube, while the liquid remains pellucid; but previous to a change for rain, the compound will gradually rise, the fluid remaining transparent. Twenty-four hours before a storm or very high wind the substance will be partly on the surface of the liquid, apparently in the form of a leaf; the fluid in such cases will be very turbid and in a state resembling fermentation.

Contributed by ARTHUR SCHALLER.

NEARLY PERFECT — WHAT 1/1000TH INCH ACCURACY MEANS.

Such is the perfection of modern machinery that 1/1000th of an inch is a large error in metal working, tho a sixty-fourth of an inch was near enough for the craftsman of fifty years ago. Optical goods, like lenses and prisms can now be made with surfaces accurate to 1/50,000th of an inch without undue difficulty, and for the most exacting purposes of scientific research it is possible to make a flat or curved surface to an accuracy of *one millionth of an inch.*

But even such marvelous accuracy as this falls far short of theoretical precision. If the most perfect mirror could be magnified until the molecules became visible, it would appear anything but flat. In fact, when X-rays were discovered this form of radiation appeared not to be subject to regular reflection like a beam of light falling upon a mirror. This has since been found to be due to the fact that the most perfectly polished surface is relatively rough to the exceedingly short waves of X-rays, just as a sheet of paper is rough to ordinary light, and so reflects it diffused.

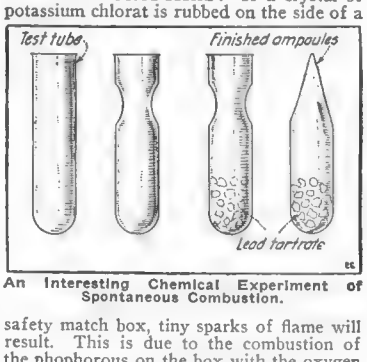
Contributed by H. J. GRAY.

PREPARATION OF PYROMORPHIC CARBON.

Pyromorphic carbon is a substance which takes fire spontaneously. It is prepared from lead tartrat. To prepare the lead tartrat mix solutions of tartaric acid and lead acetat. Lead tartrat is precipitated. This is filtered, washed and dried in the air. Next an ampoule is prepared by drawing out a test tube. (See diagram.) The tartrat is now put in the ampoule and heated until no more white fumes are given off. It is then sealed at the constriction before cooling. After it is thoroly cooled and if the tip is broken off the substance when sprinkled out will burst into flame before reaching the floor.

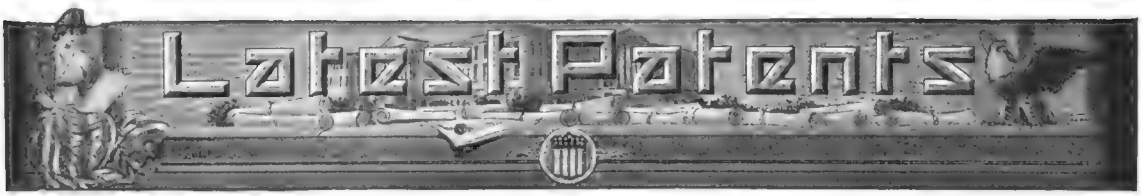
On heating, lead tartrat decomposes, leaving lead and carbon. These are in such a finely divided state that they absorb oxygen —thereby bursting into flame.

LIGHTING A BUNSEN BURNER WITHOUT MATCHES: If a crystal of potassium chlorat is rubbed on the side of a safety match box, tiny sparks of flame will result. This is due to the combustion of the phophorous on the box with the oxygen of the potassium chlorat.



An Interesting Chemical Experiment of Spontaneous Combustion.

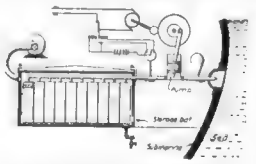
Contributed by JOE BRENNAN.



Storage-Battery Ventilation for Submarines

(1,285,659; issued to Bruce Ford)

A means of ventilating the battery cells to the exterior of the shell of a submarine whether submerged or on the surface, and an automatic way

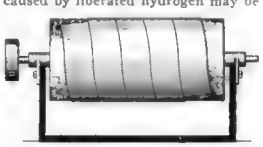


of accomplishing this object. Each one of the cells is closed and a vent pipe is connected to its interior, which is arranged to discharge thru and to the outside of the boat. An arrangement of inlet and outlet valves and an air pump regulates the discharge of the gases, acid, electrolyte, etc., that may escape from the cells by accident. Also a means of air circulation is provided around and between the cells for regulating the battery temperature.

Electrolytic Process

(1,282,262; issued to Matthew M. Merritt)

A new improvement in the manufacture of copper or other metallic sheets by electro-deposition on a rotating cathode. By proper correlation of the proportion of the surface of the cathode which is immersed, to the speed at which the cathode is rotated, the formation of rough deposits on the deposited sheet caused by liberated hydrogen may be

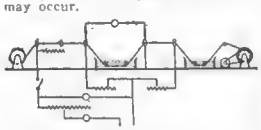


reduced to a minimum. Also the burning of the deposits by the use of a high current density may be eliminated, while maintaining that rapid rate of deposit which results from a high current density. Also the coarsely crystalline formation of the sheet which results from a high amperage during the deposit, may be avoided by the use of an oily or greasy coating over the surface of the mandrel, which is preferably treated with mercury.

Annealing Metal Wire by Electricity

(1,285,887; issued to Herbert Alexander, Wyndham T. Vint and Arthur Imbery)

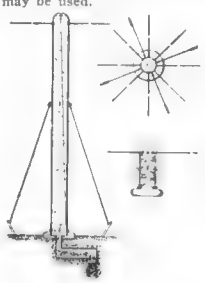
Annealing and tempering of traveling steel and other metal wire has, previously been accomplisht by its being made to form a part of an electric circuit, the ohmic resistance of the wire with the requisite amount of current flowing automatically producing the desired heat. This invention improves on this process in that it consists of a means for the gradual heating of the wire when first entering the apparatus or after emerging from a cooling bath therein, or at both stages of the process. A periodicity of over 25 cycles per second is of advantage in overcoming the tendency to the production of any electrolytic phenomena which may occur.



Collapsible Wireless Telegraph Pole

(1,285,940; issued to Leon Choda kowski)

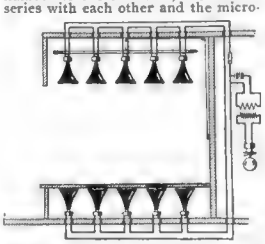
Atta-Boy, Leon! Why didn't you think of this before the war, Now we don't need it, thanks to Mr. Roger's underground radio. A wireless telegraph pole of the collapsible type for elevating the wireless antenna. It consists of a flexible and inflatable bag adapted for arrangement in pole formation when inflated and carrying wires near the top. The device is so made as to be readily filled with gas and emptied as desired. A means of carrying the gas in tanks with the signal corp section may be provided for the filling of the bag, or comprest air may be used.



Means for Recording Sounds

(No. 1,286,259, issued to Thomas A. Edison)

This invention relates to an improved method of recording sounds. Its object is the making of records for talking pictures. Where only a single horn is used to catch the sound waves a very poor impression is received on the record and many of the sound waves are not caught at all. In this invention the sound waves are collected at a plurality of points which are so separated as to extend over the field or scene. It also intensifies the impulses before they reach the recording device. A number of microphones and the receivers are connected in series while the battery and the primaries of the induction coils, corresponding in number to the receivers, are also in series with each other and the micro-

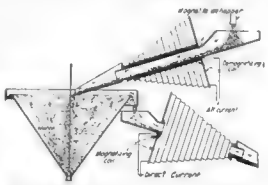


phones. The secondaries of the induction coils are in series with each other and the recorder. Therefore no matter on what part of the stage a performer may be, a recorder will always be near and enable a complete record of the sound waves to be taken.

Apparatus for Treatment of Magnetic Ore

(No. 1,286,247, issued to Edward W. Davis)

A device whereby it is possible to demagnetize magnetite ores, found in certain sections of the country. By means of this process it becomes readily possible to quickly classify the various grades of the ore. A hopper having an open top into which the ore is discharged thru a spout. This hopper also has an inclined conical spout leading from it. A coil encircles this cone thru which an alternating current is past. This conical shape has the effect of gradually reducing the influence of the

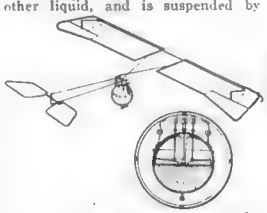


alternating current on the magnetic ore, and also prevents it from reaching a neutral point. The finer particles float away over the edge of the tank by the overflow of excess water and are remagnetized, while the heavier particles settle on the bottom of the tank.

Stabilizer for Flying-Machines

(No. 1,286,860, issued to Frank White)

A simple appliance to be used with any type of airplane for automatically controlling the balancing surfaces of the machine, thereby relieving the aviator to that extent. It comprises a hollow spherical body in two sections, with a liquid-tight joint between the top and bottom. It is adapted to contain water or other liquid, and is suspended by

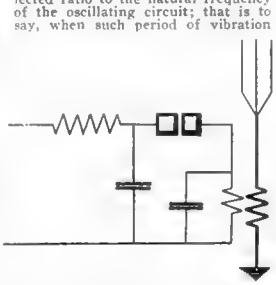


upwardly extending arms from the hangers. The arms are connected by means of pivots so as to enable the body to swing in any normal direction of flight the 'plane might assume. Any shift of this spherical body tends to raise or lower a disc which floats on the surface of the liquid and this shifting disc automatically adjusts the planes and keeps the machine in equilibrium.

Wireless Apparatus and Method Therefor

(1,279,850; issued to William Dubilier)

The apparatus consists of a simple, light weight electromagnetic vibrator intended to produce oscillations. As a closed circuit condition exists at starting the oscillations, a high primary potential is not necessary, and therefore a direct current source of energy of low voltage is sufficient to operate the apparatus. It operates most efficiently when the period of vibration of the spring of the vibrator is in a selected ratio to the natural frequency of the oscillating circuit; that is to say, when such period of vibration

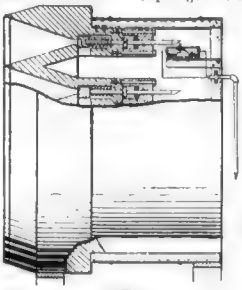


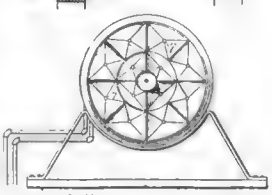
is either equal to or a harmonic of the natural frequency of the oscillating circuit.

Target Apparatus

(1,286,215; issued to Clarence H. Brainard)

Each plunger is so set in the target that it immediately absorbs all the kinetic energy of the bullet on impact and then drops the bullet into a receptacle. At the same time the movement of the plunger actu-





ates an indicator by closing a switch arranged in the path of the moving plunger, and electrically connected in the circuit with one or more annunciators, properly numbered.

Process and Apparatus for Inducing and Stimulating Rainfall

(1,284,982; issued to John G. Balsillie)

An electrical conductor is used to form a path for the flow of energy between earth and clouds. The lower end of such conductor being connected to the earth and the upper end having a terminal of electrically conductive material. To secure effective connection between earth

and clouds it is necessary to have the upper terminal consisting of a great number of fine metallic points. For practical purposes this upper terminal consists of a mat or fabric sheet of considerable surface, with a great multiplicity of electrically conductive points, and its area is two to ten square yards.

With the Amateurs

Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light-toned ones. We pay $3.00 prize each month for the best photo. Address the Editor, "With the Amateurs" Dept.

"Amateur Electrical Laboratory" Contest

THIS MONTH'S $3.00 PRIZE WINNER—E. J. J. GOBRECHT

THE accompanying photograph shows the laboratory of this month's prize winner, E. J. J. Gobrecht, who has certainly one of the most interesting that we have had submitted for some time. Everything is systematic, and there is sufficient space to have a place for everything and everything in its place. At the extreme right may be seen an elaborate switchboard containing several knife switches as well as a specially made heavy current rheostat, current meter, switchboard lamp, testing lamps, telephone transmitter, etc. Storage batteries can be charged from this switchboard when desired, and several of them may be seen on the laboratory bench in the background. The table in the foreground contains an electrolytic interrupter operating a spark coil, a pair of home-made Leyden jars and a small Oudin high frequency coil having a primary wound with copper ribbon. Several small dynamos and miscellaneous tuning coils, loose couplers and rheostats are to be seen about the laboratory showing that the owner has been actively interested in the theoretical and practical study of electricity and wireless. The usual collection of "miscellaneous" comprises telephone parts, boxes of screws and nails, wet battery elements, chemicals, etc. A goodly assortment of tools are on hand for the construction of the various apparatus which the author happens to be interested in. Note the beautiful model of a monoplane suspended in front of the central window of the laboratory, also the partly constructed model airplane fuselage on the floor just under the center table. Also do not miss the large sketch of Dr. Nikola Tesla on the rear wall, presumably enlarged and sketched from the supplement given with the "Electrical Experimenter" several years ago. There is a phonograph in the laboratory to stimulate ideas at odd moments when the owner's "think tank" goes dry. This is a good specimen of what the average American boy can do in making up an attractive and useful work-shop in which to try out his ideas and supplement his theoretical studies with the actual application of the principles involved.—E. J. J. Gobrecht, Hanover, Pa.

HONORABLE MENTION (1 Year's Subscription to the "ELECTRICAL EXPERIMENTER")—WM. H. MOORE

I GIVE herewith contents of my laboratory. Among the usual requisites of such a laboratory there are: 1 K.W. high frequency outfit, a Mignon audion cabinet, 15,000 meter coupler, together with smaller couplers, 'phones, storage battery and condensers. I also have a motor-generator set with which I charge my own and other batteries. The chemical division I think, is fairly complete. It contains a retort, pipettes, a burette, flasks, beakers and all reagents necessary for any ordinary experiment or analysis,- also tripod, ring stand, porcelain crucible, evaporating dishes, mortar and pestle, U-tube, drying tubes, conical and cylindrical graduates, hydrometers, balance, etc. The electrical division contains among other things, several motors, magnetos, etc., also an arc light, resistance, step-down transformer, telephone transmitter and that inevitable collection of miscellaneous articles commonly known to the profession as "junk." I also have a set of Marconi-Victor Code Records and receive at a speed of from 15 to 20 words per minute.—Wm. H. Moore, Charleston, W. Va.

Science in Slang

1. From Amber to Juice

By Emerson Easterling.

ILLUSTRATED BY THE AUTHOR

A QUEER man you will find him, Captain A. J. Stokes, deep and studious, yet a man of the world of sport and levity. He has nosed into every port in the seven seas and has seen the Amazon River looking east. It is needless to say he is independently wealthy. Yet it is evident that he has a speaking acquaintance with the more serious things of life, and has thumbed the pages of History and Science in his speedy course of life.

"Benny Franklin, the Lightning-rod Kid."

To-night he sat across the fireside from me at the club. In his hand he held a copy of a current electrical periodical. Seeing this, I ventured to ask, "What have you framed up in your noggin as being the right dope on the origin, use, nature and future of Electricity?"

He looked over at me and smiled a quaint smile. "That was just the sort of thing I was thinking of, the nature and future of the something we are wont to call 'Electricity'—but how happened you to ask?"

"Oh, I don't know," I replied; "I was just wondering about it myself—and I just wondered what you entertained as to it."

"This Tiled Roof—the Hon. W. Gilbert—Is Guilty of the Term 'Electricity'."

"I have smoked a carload of Havanas over this subject,"—he lit a cigar and lolled back in his chair—"from books and men I have gained some certain amount of knowledge concerning our 'Juice'.

"Way back in the dawn of History, when the dim diffused light of the dawning day of experience made its vague appearance thru the hydrous canopy that surrounded our terrestrial abode, the unknown force manifested itself before unseeing eyes. According to some authorities, we are not informed of any observations until a Thales of Miletus, only six hundred years before Christ, carved his discoveries of the funny things that amber would do when rubbed.

"Also a bird by the name of Theophrastus, who seemed to be an authority on gems, noted that when he shined some of his sparklers on his pant—(oh, excuse me! That duck wore a tablecloth) that the said sparkler would attract small objects like pith balls and lint from his culinary garb. Besides Thales and Rastus and a very few other guys who were 'on', old Jupe himself made the pith balls animated by the frictional performance engendered by lightning.

"Mike Faraday, Who Successfully 'Vamped' Dame Electra Out of a Bunch of Her Darkest Secrets."

"Funny it took so long from Creation before the old timers 'got hep' to those primary examples, isn't it? But I suppose that is what the bunch that will be here years anon will say of we present moderns.

"Of course Cleopatra must have drawn sparks from the red nose of some enamored Gaul when she shuffled across the Persian rug and did a Can-can before the Hun's grandad, some spicey morning on a winter visit up in Gallia. We know that it was static electricity, but the Egyptian Boss didn't. Neither did the Dutchman. As for that bird—it probably struck him as a severe charm of his friend, Miss Ptolemy, esq. Had you been there and slipt her the 'info' that it was what we have christened 'Electricity' that caused the prickling spark to play betwen Her Royal Ilium and Dutch's crimson beak, she would have looked at you as foolishly as could have been possible for such a sagacious female as the daughter of the Nile to look, and perhaps confess that you were talking ragtime to her. She might proffer the chatter, were she in the mood, that as near 'Electricity' as she could come was the Greek noun ηλεκτρον and the Latin *Electrum*, and

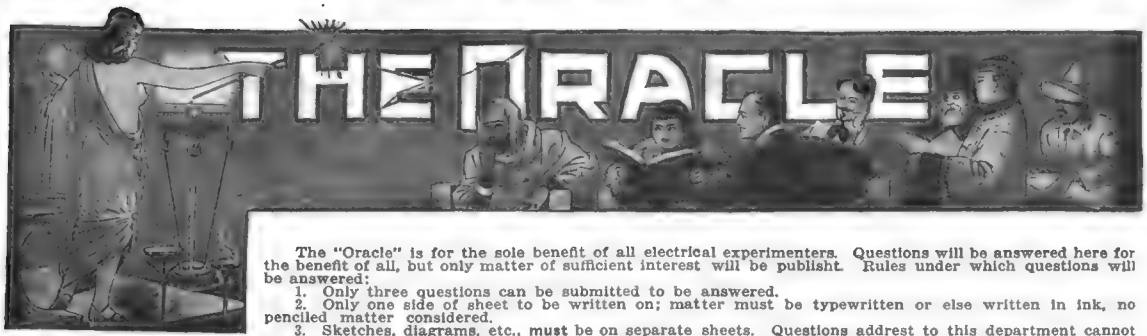
"Andy Ampère, Whom Thanks Are Due for Such Latter-day Questions as: 'How Many Amperes Has a Volt?'."

that they meant to her no more nor less than *AMBER!* Here she would probably jerk an amber dodangle from her enchanting locks and sneer, 'How could this sting me here!' clapping her jeweled digits on an also jeweled hip, 'You are dismist from court. Lack of evidence!' Whereupon you would be forced to consider yourself at bay. That was a way Cleo had about her—right or wrong.

"Nevertheless you would be right and Galvani would not be as skeptical as the Queen. No doubt, he would swallow it whole and believe you outright. Then he would more than likely demonstrate his recent discoveries on the freshly murdered frogs and calves. Of course, the Bologna physician was deluded. We all know that a Prof. from the Pavian University had to set the populace right after Doc's assertion

(*Continued on page* 812)

"Prof. Volta of WET Battery Fame. This Bird Would Have Invented a DRY Battery Sure as Nails, Even If He Had Lived in 'Bone-dry' America."



The "Oracle" is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

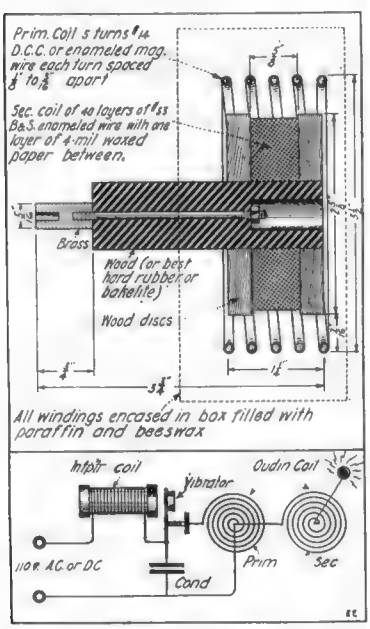
1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
3. Sketches, diagrams, etc., must be on separate sheets. Questions addrest to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of 25 cents is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

COLLINS-SANCHEZ HIGH FREQUENCY 3-INCH SPARK APPARATUS.

(983) George Litty, West Phila., Pa., inquires:

Q. 1. In the November, 1915, issue of the ELECTRICAL EXPERIMENTER you publisht an article on "High Frequency Currents and Apparata," by H. Winfield Secor. Fig. 2 shows the circuit of a *Collins-Sanchez* high frequency circuit. I would like to have the following questions answered in the *"Oracle"*:

(1) The resistance of the magnet coil and how to construct it.


Prim. Coil 5 turns #14 D.C.C. or enameled mag. wire each turn spaced ¼" to ⅜" apart
Sec. coil of 40 layers of #33 B&S. enameled wire with one layer of 4-mil waxed paper between.
Brass
Wood (or best hard rubber or bakelite)
Wood discs
All windings encased in box filled with paraffin and beeswax
Interr. coil
Vibrator
Oudin Coil
110 v. A.C. or D.C.
Cond
Prim
Sec

This High Frequency Coil Operates on 110 Volts A. C. or D. C. It Produces a 3" Flaming High Frequency Spark. The Interrupter Coil Has an Iron Wire Core ⅝" Diameter by 3½" Long. Wound with a Coil 2½" Long of No. 28 D. C. C. Magnet Wire. Outer Diameter of Coil 1¾". Vibrator Fitted with ⅛" Diameter Silver Contacts. Condenser 50 Sheets of Tinfoil 2¼" x 3¼", Placed between Mica Sheets 6 Mils Thick and Measuring 3" by 4".

(2) The capacity of the condenser.

(3) The size of the Oudin coil.

A. 1. We give herewith diagram of the Collins-Sanchez high frequency apparata, including the dimensions of the interrupter magnet, the condenser, and the proportions of the Oudin high frequency coil, the latter being best encased in a wax mould thoroly surrounding it.

10,000 METER LOOSE COUPLER.

(984) Paul H. Gebser, Roseville, P. T. Cal., writes for data on a 10,000 meter loose coupler.

A. 1. We give below data regarding the construction of a loose coupler for 10,000 meters:

Primary, 8 x 12" wound full No. 24 s. c. c. wire.

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As to what to photograph: Well, that's hard for us to say. We leave that up to you, and every reader now has the opportunity to become a reporter of the latest things in the realm of Electricity, Radio and Science. But, please remember—it's the "odd, novel or practical stunts" that we are interested in. Every photo submitted should be accompanied by a brief description of 100 to 150 words. Give the "facts"—don't worry about the style. We'll attend to that. Enclose stamps if photos are to be returned and place a piece of cardboard in the envelope with them to prevent mutilation. Look around your town and see what you can find that's interesting.

Address photos to—Editor "Odd Photos", ELECTRICAL EXPERIMENTER, 233 Fulton Street, New York City.

Secondary, 7½ x 12½" wound full No. 30 s. c. c. wire for crystal detector.

For use with audion, wind full with one layer of No. 34 s. c. c. wire.

NITROGEN RADIATOR FOR ELECTRIC HEATING.

(985) Harry B. Genders, Wednesbury, England, asks the Oracle Department:

Q. 1. I would be obliged if you would give me a few particulars regarding the Portable Electric Nitrogen Radiator, as described on page 464 of November, 1918, issue of "E. E." I presume the radiator is simply filled with nitrogen at ordinary atmospheric pressure. I should like to know if an ordinary hot water radiator could be converted to one of the above type? Also would it do if simply filled with air at atmospheric pressure? I suppose the efficiency would not be as great as with nitrogen filling.

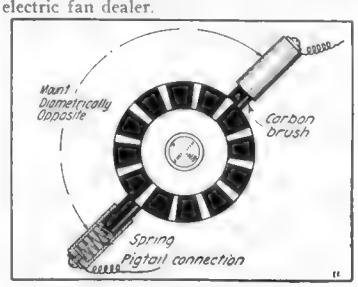
A. 1. With reference to converting an ordinary hot water radiator to an electrically heated type, most probably with a little ingenuity you could do this, but, of course, it will not be as efficient as the nitrogen filled radiator. There are several electrical radiators on the market on the principle of the simple form as you suggest, i.e., comprising nothing more than a suitably protected and insulated electrical heating element, which is caused to either heat up water with which the radiator is filled, or in some other way to produce heat in the ordinary manner.

LOW VOLTAGE, HIGH AMPERAGE DYNAMO BRUSHES.

(986) John Voorhees, Jr., Kennett Square, Pa., says:

Q. 1. I have a low voltage, high amperage dynamo fitted with copper leaf brushes. How can I apply carbon brushes?

A. 1. Concerning the replacement of the copper leaf brushes on your small dynamo by carbon or woven wire brushes, the appended diagram, we believe, will cover your requirements very nicely. Many of these small dynamos are successfully changed over in this way. The brush holders being either of the round or square pattern, should be clamped or in some way secured to the brush holder studs on your present rocker arm. You can obtain the round type brass brush holders complete with springs and brushes from any electrical repair shop or electric fan dealer.

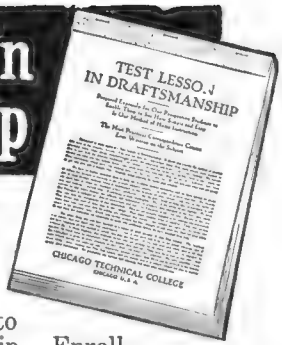


Proper Setting of Carbon Brushes on Low Voltage Dynamo, These Replacing Flat Copper Brushes Which Did Not Prove Satisfactory.

When the round type of brushes are used

(*Continued on page* 802)

FREE Test Lesson In Draftsmanship



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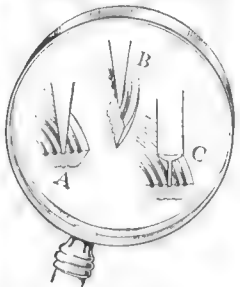

A—Ordinary Steel Needle, new.
B—As the ordinary needle wears down, *owing to its taper form*, it can no longer fit the record groove perfectly and has a tendency to wear the record.
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THE ORACLE.

(*Continued from page* 800)

a sufficient number of them should be employed to take care of the comparatively heavy current of these low voltage machines. Sometimes two or three can be placed in a row on most of the small commutators. Also a very good brush for this machine, and one of the very best that the Editor of this Department has come in contact with in his extensive motor repair experience, is that having a special grafite-carbon brush body about 1½" wide by ⅜" thick, with a woven wire core or center.

WINDINGS FOR SMALL A. C. INDUCTION MOTOR.

(987) Harry Ostness, River Falls, Wis., asks:

Q. 1. The diagram herewith shows an induction motor which I wish to wind so as to operate satisfactorily on 110 volts, 60 cycles, A. C. Can you give me data for starting and running coils?

A. 1. With regard to your query concerning the rewinding of a small 12 pole A. C. induction motor, we are pleased to give you the following sugestions on your problem:

To start with you might try winding each of the stator poles with a coil composed of four layers of No. 20 D. C. C. magnet wire. These coils are best wound on a form in a small winding jig or in the lathe, and tied by means of four springs, one in each corner of the form so as to hold the coil in shape. In repair shop practise, these coils are sometimes wound on a form in the manner mentioned, and afterward taped with white cotton or linen tape, using narrow tape in this instance, or if only a wide tape can be obtained, then this should be split. The coils may be given a coat of black asphaltum, but in most cases a piece of *fish paper* is placed around the pole-piece and the coil then placed over this, and after all the coils are in place, the windings are treated with a liberal coat of orange shellac. All of these *running* coils should be connected to give alternate north and south poles.

Regarding the *starting* coils, these may be composed of about 20 turns of No. 26 D. C. C. magnet wire, wound on a form so as to slip over one side of the pole-face. Then all coils are connected up in series to give alternate north and south poles. It may be said that the running coils and the starting coils are connected up in two circuits; the starting coils being invariably provided with an automatic centrifugal switch mounted on the shaft of the rotor so as to open the circuit as soon as the motor has attained synchronous speed.

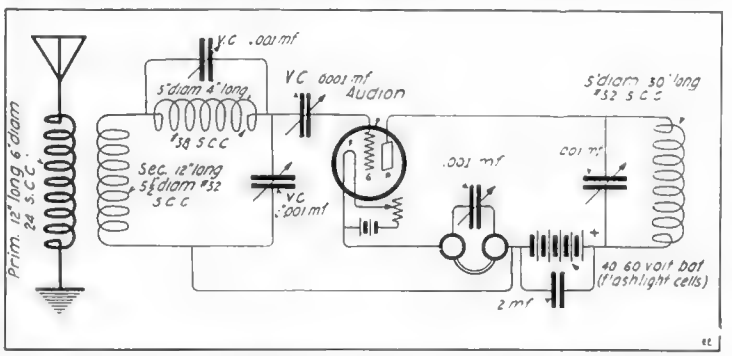
In this conection, we believe you will do very well to try the copper or brass *shading plates* which are also extensively employed. These are used on a number of the commercial A. C. induction motors below ¼ h.p. in size. They are about ⅛" thick and have a slot in them so as to fit over the half-projection of the pole shoe. One or two laminations on either side of the pole shoe are then bent over and hammered down to retain the plate in position. The rotor will revolve in the direction of the plates; to reverse the direction of the rotor, the plates should be placed on the other half-projection of the pole shoe so as to face in the opposite direction, or else the stator frame should be reversed in position. All of the shading plates, of course, must be placed on the same relative side of the stator poles in any case. To reverse the direction of a motor supplied with a starting winding instead of shading plates, the leads connecting this circuit to the 110 volt supply are reversed.

THE ARMSTRONG AUDION CIRCUIT.

(988) John M. Burrell, Pittsburgh, Pa., asks for:

Q. 1. Data on condensers, inductances, etc., for the "Armstrong" regenerative audion circuit.

A. 1. Herewith is a typical Armstrong regenerative receiving circuit. As all dimensions are given in the diagram, we deem it unnecessary to go into further details.



Arrangement of Armstrong Regenerative Audion Circuit for Receiving Undamped Signals. The Dimensions of Inductances and Capacities Are Given in the Figure.

ARC WELDING QUERIES.

(989) Wm. S.——, Torrington, Conn., writes:

Q. 1. Can arc welding be done with regular city lighting circuit of 110 volts A. C. rectified to D. C.? Would common iron wire resistance be sufficient or would a special low voltage transformer be necessary?

Q. 2. Can oxygen be produced by the electrolysis of water by 110 volt D. C.? Would a solution of acid be necessary to act as a conductor? Would the oxygen be pure enough to use for welding, brazing or burning out carbon in motors? Could any useful amount be had?

A. 1. Concerning arc welding you will find very valuable information on this work contained in a recent paper by Mr. Horner on the electric welding of steel ships read before the Philadelphia Section of the American Institute of Electrical Engineers. Copy of this paper can be obtained by mentioning the subject and the author, and writing to the Secretary, Mr. F. L. Hutchinson, A. I. E. E., 33 W. 39th Street, New York City.

Also you will find a very good article on this subject in the December issue of the ELECTRICAL EXPERIMENTER. A typical arc welding outfit is illustrated and described therein, including A. C. motor and D. C.

(*Continued on page* 804)

"Humanize" Your Talking Machine

If you have been using an ordinary reproducer on your phonograph or talking machine, you have been missing the *real* music. You have failed to hear the beautiful overtones which musicians listen for—you have heard but a poor imitation of the composition as originally played or sung by the artist. The true tone coloring is not—*can not be*—faithfully reproduced by ordinary reproducers.

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Last week when Galli Curci sang here with the Chicago Opera Company it was necessary for me to explain to one of my advanced students that it was not Galli Curci, in person, singing in your laboratory next to our "Studios" but one of her records played with your "Music-Master" reproducer.
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And another—
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THE ORACLE.

(*Continued from page* 802)

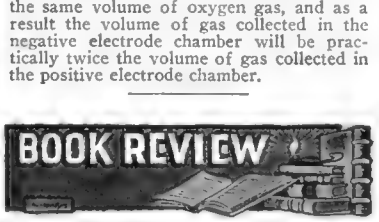
generator, as well as regulating inductances for controlling the arc voltage, which is about sixty to seventy volts usually.

A. 2. With reference to producing electrolytic oxygen from water, would advise that this is done right along commercially, and full information as to the apparatus used may be obtained by communicating with the International Oxygen Company, New York City.

This method of producing oxygen (as well as hydrogen) by passing a direct current thru vats containing water is used in the Army Balloon Corps; the lighter or hydrogen gas being used in this case for filling the balloons while the oxygen is used for oxy-acetylene welding outfits, flame throwers, etc.

The method of producing the gas consists in increasing the conductivity of the water by adding sodium bicarbonat or sulfuric acid, and a series of multiple and alternately charged, perforated metal plates are immersed in the water, one set of plates being positive and the other negative. Hydrogen gas collects at the cathode or negative pole, and oxygen gas at the anode or positive pole. You would do well in this connection to look up any chemistry book and also refer to some of the back lessons of the "Experimental Chemistry" course publisht monthly in the ELECTRICAL EXPERIMENTER, where this electrolytic apparatus has been described.

The production of the two gases causes the decomposition of the water into its constituent elements due to the passage of current thru the water. The large electrolytic generator used at the Army Balloon School at Fort Omaha, uses bicarbonate of soda. The weight of the oxygen gas liberated by a certain quantity of electricity will be about eight times that of the hydrogen gas, but the oxygen gas will occupy only one-half the space that the hydrogen gas occupies, since a given volume of hydrogen gas is approximately one-sixteenth as heavy as the same volume of oxygen gas, and as a result the volume of gas collected in the negative electrode chamber will be practically twice the volume of gas collected in the positive electrode chamber.



THE MAINTENANCE OF WIRELESS TELEGRAPH APPARATUS, by Percy W. Harris. Cloth bound, pocket size, 4¾ inches by 7¼ inches, 127 pages, illustrated. Publisht by The Wireless Press, Ltd., London. Price 90 cents.

A handy pocket manual primarily intended for the radio operator aboard ship who usually handles Marconi equipment and as such it serves its purpose. Much of the material has been covered in many other previous works on this subject so that a partial list of the contents will serve to give an idea of the ground covered. General information, such as the care of the wireless cabin, taking over the apparatus, inspections, etc. Preparing installations for laying up, transmitting apparatus, marine switchboards and their care, motor starters, converters, keys, transformers, condensers, disc dischargers, receiving apparatus, the care of the same, also the replacing of parts, the aerial and its fittings, the lead-in and the care of insulators.

A very complete chapter on the storage battery is included, which explains how to take care of the battery while in actual use, also some remarks on storing away the battery if it is to be taken out of service for any length of time. A brief concluding chapter treats on the Marconi wavemeter and its adaption to the measurements aboard ship, such as the wave length of the transmitted and incoming wave lengths.

This book is very brief in its explanations and presupposes on the part of the reader a previous knowledge of the theory of radio circuits and apparatus. Similar books have appeared on this side of the Atlantic which have been much broader in scope so far as the commercial ship radio equipment is concerned at any rate.

MODERN WIRING DIAGRAMS AND DESCRIPTIONS FOR ELECTRICAL WORKERS, by Horstmann & Tousley. 298 pages, 207 illustrations, size 6¾ x 4½ inches. Cloth bound $1.00, leather bound $1.50. Publisht by Frederick J. Drake & Company, Chicago, Ill.

This work forms a tried and true friend of the electrician and wireman. There are over two hundred diagrams of electrical apparatus covering every conceivable device with which the every-day electrician will come in contact with and be called upon to connect up, including diagrams and connections for various types of bell and telephone circuits, including the inter-communicating system so widely used in residences and offices. One section deals with connections of telegraph instruments and diagrams are given showing the connections for the electrical writing instrument known as the "Telautograph." Other sections deal with the connections of X-ray and gas lighting apparatus, primary batteries, storage cells, locating faults on circuits, electric lighting circuits and arrangements for two and three-way switching, house and office building wiring, theater lighting, etc., etc.

Other descriptive chapters, together with complete wiring connections, are given covering arc lamps, the Nernst lamp, the Cooper-Hewitt lamp, etc. Recording wattmeter hook-ups are given as well as "demand meters"; diagrams, also circuits for shunt and compound-wound motors, automatic starters, drum controller connections, street car hook-ups, electric automobile circuits, direct current and alternating current dynamo and switchboard connections, the action and connection of motor-generator compensators, transformers, switchboards, ground detectors, storage battery charging panels—with and without boosters, testing of circuit troubles and the use of the Wheatstone bridge, wiring tables giving the size of wire for various loads and circuit runs, et cetera. The closing chapter treats on electric signs, flashers and display lighting.

THE BOY'S BOOK OF SUBMARINES, by A. Frederick Collins. Cloth covers, illustrated, 220 pages, size 5 x 7½ inches. Publisht by Frederick A. Stokes Company, New York. Price $1.35.

A most interesting exploring trip into the How and Why of the submarine in plain everyday language that we may all read and understand. The important part played by this work is that it gives the uninitiated a clear and comprehensive digest of just how the "terror of the seas" operates and functions.

From the theory to the completed submarine each detail is carefully explained as the following list of contents shows.

The First of the Submarines—How to Make and Work a Model Submarine—How a real Submarine is Made and Works—The Heart of the Submarine—Making and Shooting the Torpedo—Making the Submarine Deadlier—The Wonderful "Eye" of the Submarine—The Marvelous Tongue and Ears of the Submarine—The Crew of the Submarine—How the Submarine Attacks—The New Submarine Chasers, the Last Word in Submarines.

The chapter devoted to the periscope is very thoro and clearly illustrates the principle on which it works. Directions are given for the construction of a model periscope much on the line of those in practical use.

Methods of signaling play an important part in the successful operations of the under-sea boat and these various means are given a great deal of attention. Particularly we might mention Radio—Semaphore—The Submarine Bell—and the conductivity or under-water "Wircless" which operates on a system of copper plates—induction coils, phones and a current source.

It is a very neat volume and the author has evidently done his best to enable the layman and experimenting youngster to grasp the mysteries of the U-Boat. Deserving of mention is the chapter on how to construct a real live working model that will make all these principles clear.

MILITARY SIGNAL CORPS MANUAL, by J. Andrew White. Cloth bound, 562 pages, 260 illustrations, size 5 x 7½ inches. Publisht by Wireless Press, Inc., New York. 1918. Price $1.50.

An interesting and practical volume which has undoubtedly been of great aid to all Signal Corps men during the war and which will find a place in peacetime activities of the Army.

Each and every detail, such as personnel, organization, drill instruction, various components of the different branches of a corps are described fully so that a beginner has a wealth of information at hand. Nothing is too small to escape mention, nothing is omitted.

A partial list of the contents will serve to give the scope of this work—The Signal Corps' relation to the line of the Army—Aircraft—Government and Administration—Commands and Signals—Physical Training—Instruction with Arms—The Company Mounted and Dismounted—Field Signal Troops—The Wire Company—The Radio Company—Telegraph Company—Reviews—Inspection—Manual of the Saber. A most complete chapter is devoted to technical instruction and apparatus, covering fundamentals of electro-magnetism, bat

(*Continued on page* 829)

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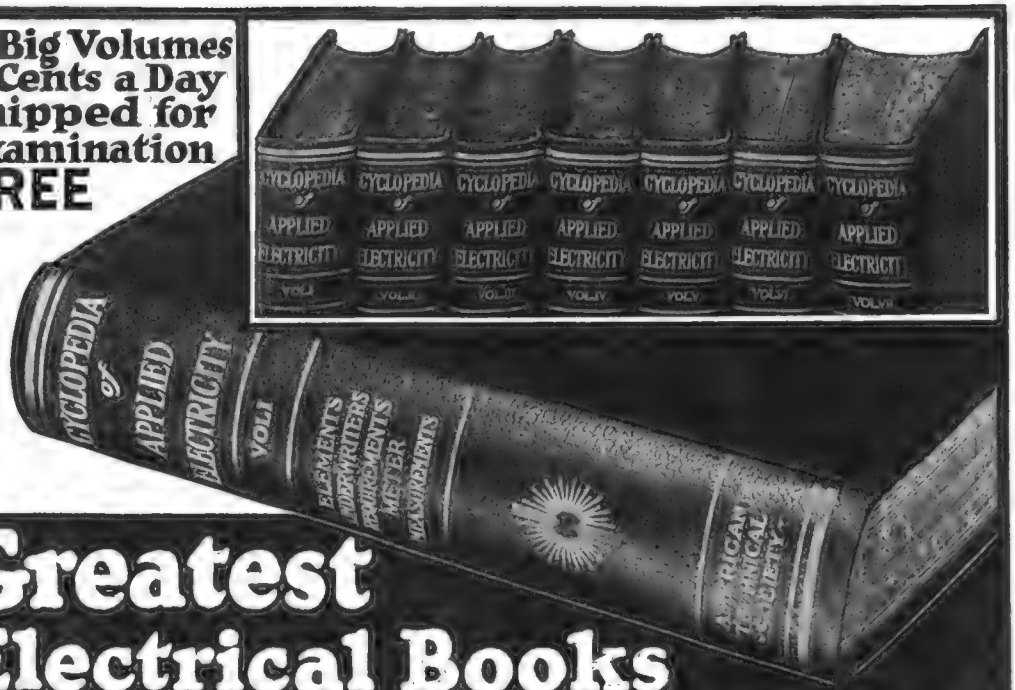

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Experimental Physics

(*Continued from page* 785)

back and forth. A sulfur bead for insulation such as F, in figure 98, is best made as follows:

Heat a small quantity of stick sulfur in a clean evaporating dish until the sulfur melts. When it becomes a clear liquid amber in color, dip the end of the rod G into it. Withdraw the rod and allow the sulfur to harden. Repeat this operation until the bead has grown to the desired size.

Experiment 110.

In conducting experiments with the electroscope all parts except the gold leaf system should be connected with the earth; since any part insulated is likely to become charged slightly and owing to the extreme sensitivity of the instrument, the gold leaf system would thereby be disturbed.

We will now proceed with the fundamental experiment of charging and discharging the electroscope. Rub an ebonite rod or ordinary fountain pen with cat's fur or flannel or your coat sleeve (or a glass rod with silk.) Bring this charged rod in contact with bent rod B, at the same time turning B so that it touches the rod G. Now by means of the charged rod charge will travel thru the conductor B to G and therefore G and the gold leaf, having the same charge, will repel each other. Since the rod G is rigidly fastened and the leaf H is not, H will spring away from G. Now by means of the charged rod bend rod C away to position of figure 99-B. Since G and H are insulated from the rest of the electroscope the charge cannot leave and the electroscope is now *charged*. To *discharge* touch the finger to the bent rod and bring the rod into contact with the gold leaf system H-G. The charge will pass to the finger and thru the body to the earth.

Experiment 111.

After the electroscope has been charged and allowed to stand awhile we find that it loses its charge slowly but surely. The rate at which the charge is lost, is called the *natural* leak of the electroscope. To measure the natural leak, set up a telescope pointing at the window of the electroscope as in figure 100-A. A paper scale may be attached in the electroscope behind the gold leaf system so that the field of view of the telescope will appear as in figure 100-B. Take readings of the telescope at equal intervals of time and the average will give a good approximation of the natural leak.

Experiment 112.

We cannot determine the presence of radio-active substances in a compound or mixture by chemical means, because these substances are found in such small quantities. We may, however, detect their presence as Becquerel did by the use of the photographic plate or by the use of the electroscope, by which method Madame Curie discovered Radium. (See Experiment No. 108). Let us recall the passage of electricity thru a liquid. The liquid ionizes and we call it an *Electrolyte*. In a similar manner, a gas ionizes, the velocity of the ions in the gas being tremendously greater than that of the ions in the electrolyte. This explains the natural leak of the electroscope, i. e., the air is somewhat ionized, depending upon atmospheric and other conditions.

Place the electroscope near the stove or radiator. We find that the natural leak of the electroscope is the same, i. e., heat does not cause any additional ionization of the air. If however a Bunsen flame is placed

(*Continued on page* 808)

TABLE 102.

Uranium-Radium Series.

Substance	Kind of Radiation	Period of Half Decay
Uranium 1	α	5,000,000,000 years
Uranium 2	α	200,000 years
Uranium x	β, γ	24 3/5 days
(Uranium y)	β	1½ days
Ionium	α	200,000 years
Radium	α, β	2,000 years
Radium Emanation	α	3¾ days
Radium A	α	3 minutes
Radium B	β, γ	26¾ minutes
Radium C_1	α, β, γ	19½ minutes
(Radium C_2)	β	1.4 minutes
Radium D	β	16½ years
Radium E	β, γ	5 days
Radium F (Polonium)	α	136 days

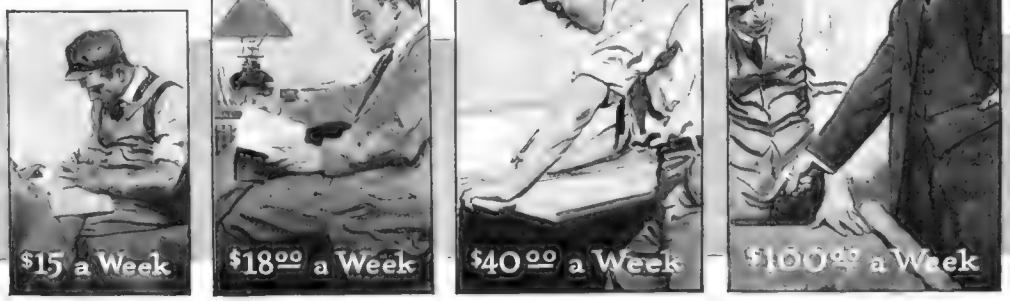
Thorium Series.

Thorium	α	13,000,000,000 years
Mesothorium 1	rayless	5½ years
Mesothorium 2	β, γ	6½ hours
Radiothorium	α	737 days
Thorium x	α	3¾ days
Thorium Emanation	α	53 seconds
Thorium A	α	1/7 second
Thorium B	β	10 3/5 hours
Thorium C_1	α, β	60 minutes
(Thorium C_2)	α	very short
Thorium D	β, γ	3 1/10 minutes

Actinium Series.

Actinium	rayless	unknown
Radio-Actinium	α, β	19½ days
Actinium x	α, β	10½ days
Actinium Emanation	α	3 9/10 seconds
Actinium A	α	2/1000 second
Actinium B	β	36 3/10 seconds
Actinium C	α	2 5/100 minutes
Actinium D	β, γ	4¾ minutes

The Man Who *Wouldn't* Stay Down



He was putting in long hours at monotonous unskilled work. His small pay scarcely lasted from one week to the next. Pleasures were few and far between and he couldn't save a cent.

He was down—but he *wouldn't stay there!* He saw other men promoted, and he made up his mind that what they could do *he* could do. Then he found the *reason* they were promoted was because they had special training—an expert knowledge of some one line. So he made up his mind that *he* would get that kind of training.

He marked and mailed to Scranton a coupon like the one below. That was his first step upward. It brought him just the information he was looking for. He found he could get the training he needed right at home in the hours after supper. From that time on he spent part of his spare time studying.

The first reward was not long in coming—an increase in salary. Then came another. Then he was made Foreman. Now he is Superintendent with an income that means independence and all the comforts and pleasures that make life worth living.

It just shows what a man with ambition can do. And this man is only one out of hundreds of thousands who have climbed the same steps to success with the help of the International Correspondence Schools.

What about *you?*

Are you satisfied merely to hang on where you are or would you, too, like to have a real job and real money? It's entirely up to you. You don't *have* to stay down. You *can* climb to the position you want in the work you like best. Yes, you can! The I. C. S. is ready and anxious to come to you, wherever you are, with the very help you need.

Surely when you have an opportunity that means so much, you can't afford to let another priceless hour pass without at least finding out about it. And the way to do that is easy—without cost, without obligating yourself in any way, mark and mail this coupon.

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Explain, without obligating me, how I can qualify for the position, or in the subject, *before* which I mark X.

- ☐ ELECTRICAL ENGINEER
- ☐ Electrician
- ☐ Electric Wiring
- ☐ Electric Lighting
- ☐ Electric Car Running
- ☐ Heavy Electric Traction
- ☐ Electrical Draftsman
- ☐ Electric Machine Designer
- ☐ Telegraph Expert
- ☐ Practical Telephony
- ☐ MECHANICAL ENGINEER
- ☐ Mechanical Draftsman
- ☐ Toolmaker
- ☐ Machine Shop Practice
- ☐ Gas Engineer
- ☐ CIVIL ENGINEER
- ☐ Surveying and Mapping
- ☐ MINE FOREMAN OR ENGINEER
- ☐ ARCHITECT
- ☐ Architectural Draftsman
- ☐ PLUMBING AND HEATING
- ☐ Sheet Metal Worker
- ☐ Ship Draftsman
- ☐ CHEMICAL ENGINEER
- ☐ SALESMANSHIP
- ☐ ADVERTISING MAN
- ☐ Show Card Writer
- ☐ Outdoor Sign Painter
- ☐ RAILROADER
- ☐ ILLUSTRATOR
- ☐ DESIGNER
- ☐ BOOKKEEPER
- ☐ Stenographer and Typist
- ☐ Cert. Public Accountant
- ☐ Traffic Management
- ☐ Commercial Law
- ☐ GOOD ENGLISH
- ☐ Common School Subjects
- ☐ CIVIL SERVICE
- ☐ Railway Mail Clerk
- ☐ STATIONARY ENGINEER
- ☐ Textile Overseer or Supt.
- ☐ AGRICULTURE
- ☐ Navigator
- ☐ Poultry Raising
- ☐ AUTOMOBILES
- ☐ Spanish
- ☐ French
- ☐ Italian

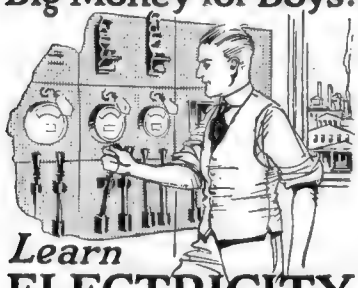
Name _____

Occupation & Employer _____

Street and No. _____

City _____ State _____

Big Money for Boys!



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Let the I. C. S. help *you*. Choose the work you like best in the coupon below, then mark and mail it today. This doesn't obligate you in the least, and it will bring you information that will start you on a successful career. This is your chance. Don't let it slip by. Mark and mail this coupon *now*.

TEAR OUT HERE

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Explain, without obligating me, how I can qualify for the position, or in the subject, before which I mark X.

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Electrician	SALESMANSHIP
Electric Wiring	ADVERTISING MAN
Electric Lighting	Window Trimmer
Electric Car Running	Show Card Writer
Heavy Electric Traction	Outdoor Sign Painter
Electrical Draftsman	RAILROADER
Electric Machine Designer	ILLUSTRATOR
Telegraph Expert	DESIGNER
Practical Telephony	BOOKKEEPER
MECHANICAL ENGINEER	Stenographer and Typist
Mechanical Draftsman	Cert. Pub. Accountant
Ship Draftsman	Traffic Management
Machine Shop Practice	Commercial Law
Toolmaker	GOOD ENGLISH
Gas Engineer	STATIONARY ENGINEER
CIVIL ENGINEER	CIVIL SERVICE
Surveying and Mapping	Railway Mail Clerk
MINE FOREMAN OR ENG'R	Textile Overseer or Supt.
ARCHITECT	AGRICULTURE
Architectural Draftsman	Navigator — Spanish
PLUMBING AND HEATING	Poultry Raising — French
Sheet Metal Worker	Automobiles — Italian

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Present Occupation_____

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Dept. 116 MILWAUKEE, WISC.

EXPERIMENTAL PHYSICS.

(*Continued from page* 806)

near the electroscope, we find that the electroscope discharges rapidly. The Bunsen flame ionizes the air very rapidly. A small quantity of radio-active material will discharge the electroscope very rapidly, showing that *radio-active materials have the ability to IONIZE the air.* The larger the amount of radio-active material the faster the rate of discharge of the electroscope. A pinch of Uranium Oxid in the electroscope chamber, will ionize the air so rapidly that the leaf will fall practically instantaneously!

Experiment 113.

A third test for the presence of most radio-active substances is the *"Fluorescence Effect"*—which some of them have upon certain compounds, especially *Zinc Sulfid.* Any of the substances which give off alpha radiations (see figure 102) will cause a zinc sulfid screen to fluoresce. If the screen is observed thru a sufficiently high power magnifying lens, or microscope (say ten or fifteen diameters magnification), the continuous soft glow of the zinc sulfid seen by the naked eye becomes, on magnification, hundreds of tiny flashes of light, not unlike the sparks obtained by striking flint and steel together. Figure 101 shows the *Spinthariscope,* which can be easily made by the reader. A is small metal tube with a hole, S, in its cap. E and F are lenses. C is the fluorescent screen on the cap of tube B. D is a small particle of the radio-active substance. A practical use of the fluorescent effect of alpha particles is familiar to all of us in the *radium paints, luminous dials,* et cetera. These compounds consist of specially prepared zinc sulfid, mixed with about 2,000 parts of radium bromid, or a radio-active compound having an equivalent of alpha-ray activity. Altho the period of half decay of radium itself is approximately 2,000 years, see table 102, the luminosity of the compound falls off, due to the fact that the *zinc sulfid loses its power to luminesce,* but not because the radium gives out. Some specifications for luminous paint, as for government work, stipulate that the zinc sulfid and radio-active substance shall be mixed in such proportions that the average useful life of the paint will be from 8 to 10 years.

The discovery of radio-activity has given us a vast field for research and as a result the physicist has been able to make subatomic investigations. Atoms are constantly exploding and shoot out as fragments, the alpha and beta particles. Altho the energy liberated by these explosions is fairly large, no diminution in the weight of the radio-active substance has been detected after the liberation of the energy. J. J. Thomson computed that the disintegration of one gram of hydrogen would liberate sufficient energy to raise a million tons 300 feet. See Fig. 103. If only this energy could be trapt, and recent research shows the possibility of it, Garfield and his coal-house gang would lose their job, for who would use ten tons of coal when one gram of hydrogen would give an equivalent heating value. Table 102 gives interesting data concerning the radio-active substances. In each series the first substance gives the second on disintegration and the second the third, etc. The second column gives the kind of radiation given off by the respective substances and the last column tells how long it takes for the substance to disintegrate to half of the original amount. This half-period means that after 2,000 years, for instance, one-half of the substance in question will have disintegrated. After 4,000 years, one-half of the remainder will have disintegrated or disappeared, etc., etc. The total life of pure Radium is computed from this law to be about 22,000 years.

(*To be continued*)

HISTORIC ELECTRIC SWITCHBOARD AND DYNAMO.

(*Continued from page* 778)

field magnet type with surface wound armatures. There are quite a number of these generators still in existence in various parts of the country, and in tribute to their designer, it should be said that they perform their duty very well indeed, considering the time at which they were built, for thirty to thirty-five years in the electrical industry has, we might almost say, witnest the entire development of the whole scheme of electrical generation, transmission and utilization of power, under the directorship of such men as Edison, Thomson, Houston, Tesla, Westinghouse and Sprague.

The wooden switch-board, shown in the photograph, contains four box-type field rheostats, and it is peculiar to note that they are mounted on the face of the board instead of in the rear, as in present day practise.—*Photo by Richard Nelson.*

THE TESLA EGG OF COLUMBUS.

(*Continued from page* 775)

Tesla had other surprises for his audiences, which were even more wonderful. So, for instance, the coil on three legs, visible in the foreground, was used to operate wireless motors, lamps and other devices, and the spiral coil in the background served to show extraordinary high potential phenomena, as streamers of great length.

ULTRAVIOLET ENERGY AND ITS USE.

By M. Luckiesh, Physicist, Nela Research Laboratory.

Since the discovery of ultraviolet rays, more than a century ago, their production and properties have been subjected to a great deal of investigation. However, notwithstanding the extensive literature on the subject we must agree with Sheppard, who says in his book on Photo-chemistry:

"We are only at the beginning of the conscious utilization of the powers of light, as distinct from the unconscious enjoyment of them."

Owing to the many unique properties of these invisible rays, they are extremely valuable in certain scientific investigations, tests, and industrial processes, and it appears certain, that with the progress of the development of sources of ultraviolet rays, and of media transparent to them, the usefulness of ultraviolet energy will be rapidly extended. The problems in which these unique properties may be utilized are manifold.

As to Sources:—There are many sources of ultraviolet energy, but few are powerful enough to be widely useful. The ideal source, which emits a continuous non-banded spectrum of high intensity thruout the entire ultraviolet region, does not exist. Some of the sources are here ranked in order: magnetite arc, old mercury arc, new mercury arc, and carbon arc.

The blue flame arc emits ultraviolet energy very strongly. It is a simple matter to construct an arc which will emit ultraviolet energy strongly, provided hand-control is satisfactory. An iron rod and a carbon rod may be employed successfully for the two poles, however two iron rods may answer the purpose very well. These poles may be kept cool effectively by means of heavy brass or copper sleeves, which may be wound along the iron rods as the latter are consumed.

Uses of Ultraviolet Rays:—Ionization of air; powerful bactericidal agent; kill germs in water; effect upon animal tissue to bronze the skin. In industrial processes such as acetylene and arc welding, which are attended by powerful ultraviolet energy, there is a demand for eye-protecting glasses.

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Paragon is also being taught in the High Schools of Alton, Ill., Lafayette, Ind., Johnstown, Pa., Atlanta, Ga., and elsewhere.

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Now you can have your wish. Because, all that you dreaded is done away with in the Paragon Method of Shorthand. Instead of committing to memory something like 4000 word-signs and contractions, which in other systems largely depend for their meaning upon the position they occupy, you have only 26 word-signs to learn in Paragon. The entire system consists of

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Twenty-six simple word-signs:

Six prefix contractions:
One general rule for abbreviations.

THAT IS ALL. The simple explanations and exercises are divided into seven lessons, the principles of which one can grasp in one evening. Speed will develop pleasantly as you make daily use of your quickly acquired knowledge.

This is the Paragon System. Thousands have learned the 7 lessons in 7 evenings. See for yourself how perfectly simple it is. Stop right here and study the specimen lesson shown above at the right.

Now you see how easy it must be to learn Paragon and how quickly one can equip himself with this great modern instrument of Efficiency.

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Our records show that in addition to the thousands of young men and women who need shorthand as a help in their business careers, other thousands—business men, professional men, students, clergymen and literary folk—would like to know Paragon Shorthand as a time saving convenience. Still others—fathers and mothers—would like to give their sons and daughters this wonderful advantage in order that they may be able to be self-supporting any time it may be necessary.

Many of these persons who have not a direct need for shorthand but want it as an instrument of efficiency and a daily time saver would buy the complete course of Paragon Shorthand at a popular selling price.

A Valuable Accomplishment Quickly Learned

Thousands of young, ambitious men and women who have failed to learn the old, complicated forms of shorthand have learned Paragon with ease. They have since become court stenographers, reporters, assistants to business heads and in many cases executives of prominent concerns and institutions. Thousands of grateful letters now in our files attest these facts. Those printed at the left are typical.

MORE EVIDENCE OF ITS MERIT

J. A. Wm. Wiersig, Principal of Luth. Evang. School, Brighton, Col., writes:

"Your system is, indeed, a short and simple one. I mastered it in less than five hours. I am now ready to practice for speed. Your system certainly deserves being advertised, and I shall certainly do my share when opportunity offers."

Try This Lesson Now

Take the ordinary longhand letter *d* Eliminate everything but the long downstroke and there will remain / This is the Paragon symbol for **D.** It is always written **downward.**

From the longhand letter *e* rub out everything except the upper part—the circle—and you will have the Paragon **E** o

Write this circle at the **beginning** of / and you will have **Ed** /

By letting the circle remain **open** it will be a **hook,** and this **hook** stands for **A.** Thus / will be **Ad.** Add another **A** at the end thus / and you will have a girl's name, **Ada.**

From *o* eliminate the initial and final strokes and *o* will remain which is the Paragon symbol for **O.**

For the **longhand** *m* which is made of 7 strokes, you use this **one** horizontal stroke —

Therefore, —o would be **Me.**

Now continue the **E** across the **M,** so as to add **D**—thus — and you will have **Med.** Now add the **large** circle **O** and you will have / (medo), which is **meadow,** with the silent **A** and **W** omitted.

You now have 6 of the characters. There are only 26 in all. Then you memorize 26 simple word signs, 6 prefix contractions and and one natural rule for abbreviations. That is all.

Paragon is Used Everywhere

Paragon is used in the offices of the largest firms and corporations in the world such as Standard Oil Company, United States Steel Corporation and the great Railway Systems.

You have reached the point where you must know shorthand to do yourself justice and compete with others—as a busy executive or as a beginner in business.

You know how it is. Two good men apply for a position—one knows shorthand and the other does not—the shorthand man wins every time. And the same applies to young women.

Remember how many of the biggest men in America got their start because they could write shorthand—Frank A. Vanderlip, George B. Cortelyou, William Loeb, Jr., Edward Bok and other men of highest achievement.

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Never before has American business felt so keenly the shortage of capable shorthand writers. Big business houses are looking everywhere for shorthand writers and are ready to pay any salary within reason to get the service they must have. Salaries are steadily advancing—and yet the demand for shorthand writers has not been supplied.

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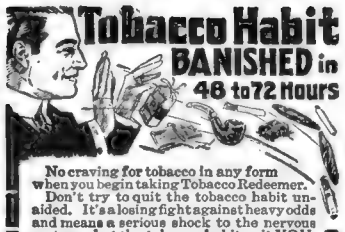
You may send me the Complete Course of PARAGON Shorthand with the distinct understanding that I have 7 days after its receipt to either remail the Course to you or send you $5.00.

Name
Business
Address

Electrical Experimenter—3-19



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SORTING TOBACCO LEAVES BY ELECTRICITY.

(*Continued from page* 770)

duplicate of the first section, except that here a permanent stop is provided in the path of movement, which will prevent any leaf from returning to the starting point, but deposit it in the box provided for the longest leaves.

All boxes, ten at each side of the machine, are standing on a kind of steps, so that each one is, according to the incline of the covers, a little below the foregoing one. As the other side of the machine is but a duplicate, the device being a double action machine, there are ten boxes for ten different sizes of leaves at each side, or 20 boxes altogether.

The contact segments on the table are movable, and the machine can thus be so finely adjusted that it will not only measure and sort the leaves by *inches* as required, but even up to a *quarter of an inch* if so desired. The machine is driven by an electric motor, arranged below the table and not visible in the illustration, and by means of an electric regulator the speed of the machine can be regulated to meet the speed with which an operator is able to place leaves upon the feeding belt.

33 ASSEMBLED LOCOMOTIVES ON ONE SHIP.

(*Continued from page* 765)

expert locomotive engineers for assembling and it took the better part of a week before even one engine was complete. The locomotives had to be in complete running order here in the shops, as well as having all the parts of the machine carefully marked before being disassembled on this side of the pond. All this entailed many days of extra and unnecessary work—especially when time was at a premium. Those and many other delays occurred so that at one time there were thirteen ships loaded with *knocked down* locomotives in ports in France waiting for the discharge of their cargoes.

This was the situation confronting the Shipping Control Committee on January, 1918. The locomotive problem was immediately discust in detail to see if there was not some way by which the complete locomotives could be sent across the ocean intact.

The steamships Feltore, Cubore, and Santore, each 468 feet long, with three great holds and five hatches, the smallest of which was 33 feet by 37 feet and the largest 39 feet by 37 feet, were then prest into service. Each ship had a cargo capacity of 11,000 tons and was fitted with electric turbines capable of driving the ship at a speed of ten knots.

On May first loading started, and the holds of the steamer Feltore were floored off with five layers of railroad rails and splices to secure a firm foundation and also to protect the hull of the ship. Next day a railroad float came alongside with eight assembled locomotives ready for the trip.

The problem of lifting these great locomotives into the hold of the ship was solved by requisitioning one of the largest cranes in the world capable of lifting 150,500 pounds in bulk. The derrick captain took his stand on the deck of the steamer and by the use of electric signals directed every movement of the crane. And so without a single hitch, each and every one of these steel-bound monsters of the rails, was lowered and set on heavy oak planks; after which tons of comprest bales of hay and bags of oats were packed around them. And so seven days after the start of this great trip, there were on the wharves at Brest, France, 33 large assembled locomotives and tenders, 2,400 tons of rails and splices, 2,300 tons of hay, 600 tons of oats, and fifty-three motor trucks.

WOOD FINISHING FOR THE AMATEUR.

(*Continued from page* 793)

either of two ways, which are known among wood finishers as the "quick" and the "slow" methods of polishing.

The quick method is as follows: Dip a handful of raw cotton into a mixture of half peanut oil (refined cottonseed oil will do), and half alcohol, and rub the surface with a rotary motion, which will give a fine lustre in a short time.

The better of the two is the slow process. After the work has been brought to the dead finish mentioned above, put on an extra coat of finishing varnish, allow it to dry, and rub down again with FF pumice stone, cleaning up carefully. Then rub ground rotten stone over the surface with a soft chamois skin, using a circular motion, and when this is dry, rub it off with the palm of the hand.

There are several other kinds of polishing, notably wax polishing and oil polishing, which may be used if desired. In wax polishing the polish is put on at the same stage that the varnish would have been applied, using any method convenient to get the wax on the work. Perhaps the best way is to warm the wax and apply it with a brush, the same as varnish. This gives an even coat of wax, which is then polished with a hand cloth. There are a number of manufactured waxes on the market, any of which will give the desired results. The chief objection to wax polishing is that it mars very easily, but it is also renewed very easily, hence this is not such a serious objection for many kinds of work.

Oil polishing is the most durable of any, and therefore is often used for table tops, counters, etc. The process is very simple, but heartbreaking. It consists of applying either raw or boiled linseed oil upon the surface, and then rubbing it until a polish is secured. The polishing is done by means of a piece of felt wrapt around a heavy block, to give it weight.

This is about all that need be said about the various processes used in wood finishing, but a brief description of the various kinds of woods commonly used by the experimenter would not be out of place. A perusal of the list will often help determine the kind of wood required for any particular piece of work.

Birch.—Black birch takes on a fine polish, as it is close grained. Its natural color is light, so it is usually stained in imitation of black walnut or mahogany. Owing to its close grain, a filler is not absolutely necessary, but when staining this wood to imitate some other, a properly colored filler gives it a better coloration.

Cherry.—This wood is very close grained, and will take a high polish. It has little tendency to warp, and because of its close grain filling is not necessary, and shellacking will prepare it for any of the finest polishes.

Oak.—Oak is the "King of woods", and is very useful. It has a medium openness of grain, and *must always be filled before shellacking*. Almost any sort of polish may be used for finishing oak, one of the most beautiful being the "antique" method, a formula for which has already been given. The linseed oil polishing will also make an excellent and durable finish. There is but one objection to this wood for wireless apparatus, which has made it unjustly unpopular, and that is that the acid in the wood has a peculiar effect upon hard rubber panels.

Mahogany.—If expense were not an objection in most cases, mahogany would be an ideal wood for every purpose. It is coarse grained, requiring a filler, but is sus-

(*Continued on page* 812)

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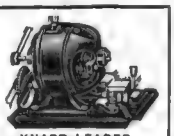

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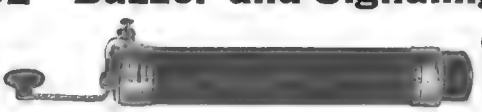

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WOOD FINISHING FOR THE AMATEURS.

(*Continued from page* 810)

ceptible of a fine polish, which makes it much in demand.

Maple.—Hard maple is close grained and requires no filler, but soft maple is just the opposite and hence is of little value. It looks best in its natural color, very light, which is preferably obtained by the use of white shellac and the very whitest ivory varnish to be found. Hard maple takes the finest polish of any of the woods.

Black Walnut.—This is a dark-colored wood, rather open grained, requiring a filler to match its color, but no stain. One good coat of orange shellac will suffice to level its surface previous to polishing.

Pine, Poplar, etc.—These soft woods are open grained and easily worked. Having little beauty of their own they are usually stained, but we should remember that oil stains are the best to use, owing to the difficulty of getting an even coat. Shellac will do very well as a varnish for these soft woods, being applied on top of a liquid filler.

In conclusion it is to be hoped that anyone attempting to do wood finishing will do the wood justice and conscientiously perform all the operations required. Everyone has preferences as to the finish liked best, but after a study of the foregoing it should not be difficult to select the right one.

FORMER KAISER CONSTANTLY IN TOUCH WITH BERLIN.

The former Kaiser is believed to be constantly in communication with Germany. It is reported that a wireless station has been erected on top of Count von Bentinck's castle, and that German airplanes frequently fly over the estate, dropping messages.

SCIENCE IN SLANG

(*Continued from page* 799)

that it was the inherent what-you-may-call-it in the deceased animal and not the contact of the two dissimilar metals on the nerve and muscle, and the chemical action created thereof, that caused the amphibious corpse to do the post-mortem Hula.

"Even at that the Dago doctor opened up a lot of dope that the terrestrians were dead to, and laid another foundation rock for the next of the scientific gang to add to. And now we have galvanic current instead of homeric, as would be the case had the blind ditty writer pulled the stunt.

"Then Count Professor Allesandro Volta, B. S., enlightened himself with Couronne de Tasses (no, not demi-tasses) and piles, and condensing electroscopes, not to speak of the other heterogeneous paraphernalia that would make a Hebrew junk dealer itch in the palms. Well, Aleck stamped his cognomen in the pages of electrical history, as well as on fuse plugs and such other electrical stuff that has the potential inscribed on it.

"Here comes along André Marie Ampère and drops the aching public a string of facts tabulating a stack of laws governing the flow of the 'juice' and propounding with such effect that we now waltz into the store and order the fuses that we shot—or rather to replace the ones we shot—by the ampere (unless we buy them by the dozen).

"So it goes. Watt then bounces into the limelight and does his act and exit. Then, when they are sure he is dead, some favoring gink—generally a Prof.—names something after him. In this case it happened to be the great what-is-it. So, too, we get ohms and farads—see; Mike's handle was too long for laboratory use so the printers just stuck in the first half dozen characters and let it go at that. Likewise we amputated

the 'a' in Volta's name when we translated it into sure-enough language. You know we humans that have descended from the Angles and Saxons got a little more efficient and sawed off the sing-song trailers some time after Chaucer wrote 'Whyne that olde Aprille why the its shores sote' and sang it like a Swede, and say 'When the sweet showers of April' just like we say volt instead of volta.

"Since Bill Gilbert, way back in the fifteen hundreds, christened the phenomena that made amber famous 'Electricity' and dumped it onto the English-speaking people we have had names, terms, epithets, descriptions, designations, and appellations galore for its numerous manifestations; yet with all the wonders of the genii we are no nearer the solution of the something we call 'Juice'. We have a fair working knowledge of what it is *not*, and how it affects various substances — including *homos*.

"Jimmy Clerk Maxwell, the bonny 'Skoatchmahn' (accent on the first syllable), let loose with a gob of new stuff that have been pacemakers for a raft of scientific birds to follow up on. Jim's dope on the gas and light—while not the kind that affect the meter men—have apparently been agreed to in the main—even since he gave the proverbial bucket the fatal rap, and can't argue back at us.

"Naturally, as time ticks off, some wise guy, who has the advantage of the ones before by being behind, springs new stuff now and then.

"The Swedish Prof. who is almost guilty for the electron theory of matter, does not blankly contradict the dope now out on molecules and atoms and ions. The latest is only a new sprout on the tree of knowledge.

"Of course Madame Curie, when she got to meddling with pitchblende, nearly uprooted the chemical tree of knowledge with her 'Radium'. Naturally, as new dope shows up, we have to show the door to a lot of the old stuff, but when some guy slips us something from observation it turns out to be almost right in its percentage. The next guy looks a little farther and hands us a little more of the same thing, generally.

"Old Ben Franklin got the fluid idea—a lot of it right. Then as a little more of eternity reels off, converting the present into the past, the 'fluid' idea went 'fluey', and we conceived the phenomena as a vibration, of molecules, atoms, ions, and finally electrons. Some of the wise guineas have the vibrations all mapt out as colliding, circling, and vari-speeded particles of *almost nothing*, making up everything we are acquainted with and a lot that we are not. The only difference between the skull of your dome and the macadam on the road in front of your house is the difference in speed or direction or path. You don't need to take that as an insult—I could have used my own head for example, but my modesty forbids.

"As we sit over an electric heater we have to hand it to old man Joule. And after we are run over gracelessly by one of those 'noiseless electrics' we may be excused for giving Mike Faraday the verbal journey to Dante's pleasure resort for a delightless season of eternity, for it was old Mike that made the first electric motor mote. This old boy had a lot to do with induced currents, and from his inductions and deductions that transformer out on yonder pole was made a pot instead of an engine boiler or crowbar.

"Of course we'll not pass old boy Nick Tesla up—the 'high frequency kid'. His alternating current stuff and three phase dope—remember that trash the engineers howled 'It can't be done' at? Funny tho—our best motors are the three phase kind now.

"When alternating current flops down the

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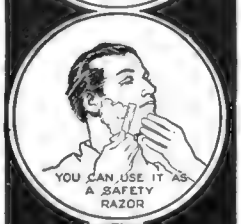

YOU HAVE A BEAUTIFUL FACE

BUT YOUR NOSE?

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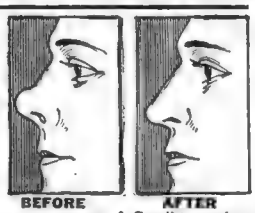

AFTER

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line, along comes a lot of other by-product stuff. A load of new hypothetics and another load of theories to explain them. You know when you hook up some plants in parallel that there enters into the circuit a condition known as 'harmonics' that juggles the peak around and cuts it off, and goes negative when the generators are trying to make a positive impression on the line. Alternating current is great stuff and the guy that can get reactance and impedance kicking right and pull the wattless current off the line don't need to worry about such prosaic things as room rent and meal tickets.

"Steinmetz has this alternating current stuff pretty well under his hat and can tell you just what will happen, and when and why. If you ask 'Steiny' how he figures it he will tell you with a paper and pencil—if he did not do it in his head; but when the figures run into ten or more columns he generally reaches for his pencil. With his calculus he calculates the two-stepping oscillatory currents correctly thru his heavy cigar smoke.

"Surely we all know what Tommy Edison has done to us in the line of sidewalks and phonographs, in stock tickers and electric lights, in street railways and chemistry. That old duck works overtime seven days to the week and sleeps with his hat and shoes on, with a copy of Clerk Maxwell's dictionary for a pillow. Yes, Tom is a bright boy.

"To-day, after all the headlights and sidelights on history, we know more about, and less of, the so-called 'electric' force that causes our incandescent globes to glow and the amber to attract pith balls than our progenitors who wore fig leaves and bedspreads.

"Perhaps some day a man—maybe a woman—will come along and kick the mud out from the electrical puddle and let us see what a 'watt' really is. At least we will find more things that the mysterious force is the cause of. We may add to our frictional, static, dynamic and other present forms we have so far classified yet more. High frequency may be the way to it—it may not. We realize that we merely collect or cause to flow in our set paths the 'juice' we use, we do not create it. In a way we are unbelievably crude in our field of electricity. A lot escapes us, a lot leaks, as it were, and we get the use of a very small amount for the work we put into it and get out. Yet it is the most, or one of the most efficient forms of energy that we now have at our disposal. Perhaps some one will stumble on to some other source than dynamos and batteries for our supply—it may be a sort of collector or etheric accumulator. Thru electricity we may overcome gravitation. The conditions that would make possible are unlimited. Of course, that is supposition, but 'wireless' and the World War were all suppositions a few years ago.

"Speaking of wireless, Hertz looked over our heads and saw something we had overlooked since Galvani's 'return shock' on the frog's hind kicks. Then Marconi and others, notably De Forest, boosted the proposition along, so that now, with the audion amplifier, we transmit music, both chin and instrumental, for miles and miles on thin ether. Whether next we will transmit or merely collect energy for power I don't know, but I would not be surprised at either.

"Some scientists tell us that once our present planet was a whirling mass of nebulae. Later it concentrated into a rough globular mass. This was known as the Azoic Age. At this time its minerals and water were thrown off at a great distance in a gaseous state. As these cooled they formed rings or films surrounding the earth. Later these rings descended upon the earth, periodically. Thus the earth past thru the Paleazoic and Carboniferous

epochs, after which fell the remaining mineral rings, and animal life came into evidence. Then the last canopy, of hundred per cent. proof water descended, and we had the big washout known as the 'flood', where a man by the name Noah—who was *his* press-agent?—made his big hit with the historians.

"Now these science hypotheticians tell us that there is yet another ring, an electrical canopy, that, when it descends will destroy all microbes and other infamous micro-organisms—Mr. Flu included in the first row. Taking that into consideration we would be a healthier flock of mortals—but fermentation is caused by our minute friend-enemies; and no fermentation means natural prohibition. How would you like that? Besides upsetting the brewers and bakers and what else not including bacchic celebrations, it would probably upset our present electrical system, and likewise rules and laws. That is the Valian theory of the thing, and there are whole reams of other dope by other thinkers and numbskulls, but this Valian hunch hits me as plausible, and a lot of the other ding-dongs sound to me as if the author had had one too many under his belt.

"If the ring were to tumble—we would be in the same fix with the antediluvians as to the liquor question. The great liquor question would no longer be 'What drink will you have?' but 'When will the ring rise again?'

"By the way, I have a quart in my room," Stokes hinted as we arose to leave, "And you can never tell when that ring may fall."

AN AMPHIBIAN LAND, WATER AND AIR HYDROPLANE.

(*Continued from page 773*)

ranged along the center line of the superstructure on the exterior are a plurality of planes, which are maintained in the proper position by means of guy rods. Horizontal rudders are arranged in opposite pairs, each consisting of a series of blades mounted upon central shafts. All of the rudders and propellers are controllable by the aviator from within the cab, and by actuating the various rudder and plane coptrols, it is thus possible for the operator to cause the craft to fly on a level keel, or to turn at any desired angle, either upward or downward.

This amphibious airship is caused to fly thru the air by means of a pair of powerful propeller blades disposed on opposite sides of the gas bag frame as shown, and at the center of the ballonet superstructure. These propeller blades are driven by the motor situated within the car by means of bevel gears. Coney Island and the rest of the amusement parks threaten to take all of our spare nickels and dimes this summer, with such irresistible and fascinating diversions as this before us.

CONCRETE WIRELESS MAST IN CHINA.

A mast of concrete 150 feet above the wall of the Tartar City, near Chienman, has been erected for the United States naval wireless. The column is 18 inches in diameter at the base and 12 inches at the top. Its weight is approximately 30,000 pounds, and it includes 2,500 pounds of reinforcing steel and 160 cubic feet of concrete. Twelve guys, fastened to four anchor blocks, secure the mast. The work was completed in seven weeks.

HARVARD RADIO SCHOOL TO BE REMOVED.

The naval radio school in Cambridge, in which nearly 5,000 sailors are under instruction, is to be removed to the Great Lakes Naval Training Station by April 1.

How I Increased My Earnings From $2 to $200 *a Day!*

The Remarkable Story of a Young Man's Experience After Reading a Wonderful Book, as Told by Himself

SOME people say it takes money to make money—others complain that they never made money because they never had any luck. When one is up against the stern reality of making both ends meet, it is natural to feel that if they only had a little money, or a little luck, they wouldn't have to worry about their bread and butter, and rent, and clothes.

A short time ago I, too, felt that way. I was a bill clerk earning only $12 a week, and I used to worry myself sick about my future.

To-day—it seems like a dream—all my financial troubles are over—my weekly income instead is about $1,000—more than I know how to spend. I own two automobiles and have a chauffeur to drive me around. My children go to private schools. I have just purchased, for cash, a $25,000 home. I go hunting, fishing, motoring and traveling, whenever I care to. I live in a new kind of world.

Possible to Anyone

Let me say in all sincerity that what I have done, I believe any one can do. I am only an average man—not "brilliant"—have never gone to college — my education is limited. I know at least a hundred men who know more than I, who are better educated and better informed—yet not one of them has made as much money as I have, their earnings probably averaging less than $50 weekly. I mention this to show that earning capacity is not governed by the extent of a man's education—to encourage those who have not had the advantage of a comprehensive education.

What, then, is the secret of my success? Let me tell you how it came about.

How I Discovered Myself

One day, about three years ago, something happened that woke me up to what was wrong with me. It was necessary for me to make a decision on a matter which was of little consequence. I knew in my heart what was the right thing to do, but something held me back. I said one thing, then another; I decided one way, then another. I couldn't for the life of me make the decision I knew was right.

I lay awake most of that night thinking about the matter—not because it was of any great importance in itself, but because I was beginning to discover *what was wrong with me.* Along towards dawn I resolved to make an experiment. I decided to cultivate my will power, believing that if I did this I would not hesitate about making decisions—that when I had an idea I would have sufficient confidence in myself to "put it over"—that I would not be afraid of myself, of things or of others. I felt that if I could smash my ideas across I would soon make my presence felt. I knew that heretofore I had always begged for success—had always stood, hat in hand, depending on others to give me the things I desired. In short, I was controlled by the will of others. Henceforth, I determined to have a strong will of my own—*to demand and command what I wanted.*

With this new purpose in mind I applied myself to finding out something more about will power. Finally I encountered a book written by Professor Frank Channing Haddock. I was astonished to read his statement. "The will is just as susceptible of development as the muscles of the body!" It is almost needless to say that I at once began to practise the exercises formulated by Dr. Haddock, and I need not recount the extraordinary results that I obtained almost from the first day. I have already indicated the success that my developed power of will has made for me.

But it may be thought that my case is exceptional. Let me again assure you that I am but an average man, with no superdeveloped powers, save that of my own will. And to further prove my contention, let me say that since Prof. Haddock's lessons, rules and exercises have been published, I have come across hundreds of other cases where strengthened will power has brought success and fortune to people who were failures, has enabled thousands to overcome drink and other vices, almost overnight—has helped overcome sickness and nervousness, has transformed unhappy, envious, discontented people into dominating personalities filled with the joy of living.

What You Can Do

I have been authorzied by the publishers of Prof. Haddock's methods to say that any reader who cares to examine his startling book on will power may do so without sending any money in advance. In other words, if after a week's reading you do not feel that "Power of Will" is worth $3, the sum asked, return it and you will owe nothing. When you receive your copy for examination you will be interested in the studies on The law of great thinking; How to develop analytical power; How to guard against errors in thought; How to drive from the mind unwholesome thoughts; How to develop fearlessness; How to use the mind in sickness; How to acquire a dominating personality, and hundreds of other similar personal power studies.

It is interesting to note that among the 250,000 owners of "Power of Will" are such prominent men as Judge Ben B. Lindsey; Supreme Court Justice Parker; Wu Ting Fang, ex-U. S. Chinese Ambassador; Senator T. B. Calron; Gov. McKelvie of Nebraska; Assistant Postmaster-General Britt; General Manager Christeson, of Wells Fargo Express Co.; E. St. Elmo Lewis; Senator Arthur Capper of Kansas, and thousands of equal prominence.

As a first step in will training, I would suggest immediate action in this matter before you. Use the blank form below, or write a lettter addressing it to the Pelton Publishing Company, 30F Wilcox Block, Meriden, Conn., and the book will come by return mail. This one act may mean the turning point of your life, as it has meant to me and to so many others.

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Announcement

The Moorhead Laboratories, the largest exclusive manufacturers of Vacuum Valves in the world, have been busily engaged during the war in supplying Vacuum Tubes to the British and United States Governments.

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Gigantic 1,400 K.W. Radio Station at Lyons, France

(*Continued from page 791*)

work, it having been found readily possible to synchronize two such high-speed radio-frequency alternators at the works of the General Electric Company, some years ago.

North of the main antenna switch platform at the center of the station, there is a French design of static frequency multiplying system rated at 150 K.W. This set operates on the principle of the transformer frequency-changing principle, as developed by Joly and Arco.

Next we come to the western wing of the station, and here there are two of the largest arc oscillation generators ever built. They were designed by Mr. C. F. Elwell, formerly chief engineer of the Federal Telegraph Company of San Francisco, Cal., who first developed the Poulsen arc system to large powers, and each of these gigantic arcs are rated at 250 K.W. Either of these arc generators may be connected to the antenna thru the central antenna switch-gear, the lead wire running to the arc sets terminating in a massive single-pole, double-throw change-over switch, about five feet in length, which permits the instant connection of either set to the antenna.

Either of these powerful arc sets can be operated from the 300-K.W., 750-volt, direct-current motor-generator set, shown in the plan view and situated just west of the arc apparatus itself. This motor-generator comprises a three-phase alternating-current motor, direct-connected to a 750-volt, direct-current, 300-K.W. generator, which supplies the necessary high voltage direct current for operating the arcs. Dr. de Forest states that in his opinion, these large arc generators represent one of the very finest developments in radio transmitters that have yet been conceived and perfected. They have a distinct advantage over radio frequency alternators in that quick changes in wave length or frequency can be rapidly obtained, merely by changing the inductance and capacity in the oscillatory circuits connected to the arc itself. The radio frequency alternator is very reliable, and develops its full power in a very constant and reliable manner, but it is difficult, at least with the present design of this machine, to obtain with speed and efficiency a considerable change in the range of wave lengths and frequency, yet as Dr. de Forest has intimated, they are very efficient and desirable where the proper operating conditions are available, such as where but one or two wave lengths only are desired. The arc generator, on the other hand, is very simple and rugged in design, and requires but very little attention, even when operated over twenty-four-hour non-stop periods, which is often the case nowadays at many of the Government stations which are using arc sets, and many of which are in very successful operation in some of the largest stations of the United States as well as in Europe at the present time.

All of the transmitters at the Lyons station operate on long wave lengths, as the reader will perceive from the antenna frequency values given above, and the undamped wave system is used in all except the spark sets. The receiving apparatus is very elaborate, and has been installed in sound-proof receiving rooms, so as to realize the very highest efficiency in the receipt of long distance signals. The French radio engineers are using nothing but three electrode audions in all of their work, and one of their bulbs will be illustrated and described in the April issue. The French receiving sets make use of two or more amplifier bulbs, and when necessary a six-stage amplifier is used, which boosts the strength of signal received 1,000,000 times. Some of the clever work accomplished by the French Army and Navy radio experts during the war, with these powerful audion amplifiers can readily be imagined, and it is a matter of record that many valuable radio as well as regular telephonic and telegraphic wire messages of the Germans were tapt by French stations equipt with these powerful amplifiers.

The power for the Lyons radio station is transmitted for a long distance from a hydro-electric plant. The receiving apparatus was built by the Compagnie Generale Radiotelegraphique, whose shops are near Paris. The detector is, of course, the French type of audion. They employ a six-step audion amplifier, using the same standard type of bulb both for detecting and amplifying.

The ground connection of the station consists of a large number of copper wires radiating from the station and buried about two meters (6½ feet) below the surface of the earth. Many of these wires terminate in copper plates.

HOW I INVENTED THE AUDION.

(*Continued from page 790*)

plication was not filed until the following February. The drawings, Figs. 2 and 6, of this patent show the incandescent or glow members both in the air, and sealed within a closed chamber.

It will be noted now that I approached the general problem of this new type of detector from an entirely different angle from that commonly supposed to-day. In the first place I always employed a battery, and this original battery was what is now universally called the "B battery." My source of electric current for heating purposes was second, and secondary, so that the vociferous contention of the advocates of the Fleming valve that the audion evolved from the Fleming valve, and was originally the Fleming valve with the "B battery" added as an afterthought, is entirely untrue.

It was now a very obvious development of the evolution thus far described, to partially exhaust the glass envelope containing the two incandescent electrodes, or filaments, so as to increase the conductivity of the space between them.

But Fig. 5 of this patent, showing the inclosed filament in a vacuum bulb, is interesting from another consideration because it contains the *first embryonic germ* of the later "grid" or *third electrode*. It was realized from the very first that a certain proportion of the high frequency energy from the antenna could be lost thru the bypath circuit supplied by the battery and telephone receiver. In order to prevent this the arrangement shown in Fig. 5 was tried out, wherein the local and high frequency circuits are kept separate. In this arrangement, as actually tried in the gas flame, no actual advantage was observed, because the high frequency electrodes were necessarily some slight distance from the path conducting the direct current, and hence the effect of the high frequency currents upon the ions carrying the local current was weakened.

During the years of 1904 and '05 my duties kept me almost continually away from my laboratory, in travelling about the country directing the installation of numerous radio stations; consequently there was little opportunity for prosecuting this development work, and carrying out the designs and sketches which I made from time to time. In fact, it was not until 1905 that a lamp manufacturer was found to undertake the construction of the various experimental forms of lamps which I had designed as a successor to the flame or arc detector. I was familiar in 1905 with Prof. Fleming's work on the subject of the "Edi-

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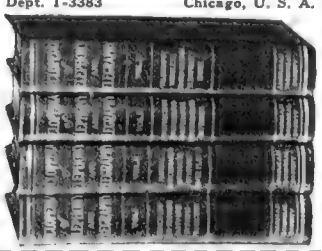

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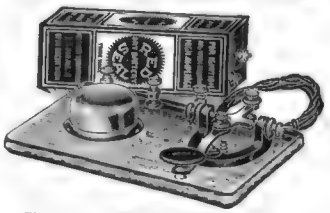

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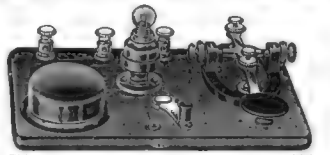

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son Effect" as utilized for the rectification of high frequency oscillations, or currents. This was interesting to me only as an evidence of growing activity along lines similar to those of my new detector. I was familiar, of course, with the phenomena originally discovered by Edison, and investigated and developed by Howell, Fleming, Wehnelt, et al; but from the very first of my work with radio detectors I always had in mind a *relay*, in the true sense of the word, *not a rectifier;* in other words, a detector in which the energy of the audible signal was supplied from a local battery. This local energy being merely controlled or released by the incoming signal. It had always been obvious to me that such a device should be more efficient than any form of rectifier where the signal indication is effected *only* by the energy actually received thru the antenna.

Fig. 1, Patent No. 824,637, is an obviously practical development of Fig. 5 of my first patent, No. 979,275. In this figure two incandescent filaments are sealed in the glass bulb, and each lighted from its own "A" battery. Here, as always, the original separate "B" battery is shown.

This figure is interesting to many, who until recently, if even now, have never heard that an audion of this type works equally well whether both electrodes are incandescent, or whether one is incandescent and the other cold. It might be well to point out now in this connection that during the patent trial—the Fleming valve vs. the Audion—a demonstration was made before the court where all three electrodes were in the form of filaments, where each could be heated to incandescence by a separate battery. The demonstration showed that when this device was connected up as an audion that either outside filament could be used as the "plate" electrode indifferently, and the signals were of the same intensity whether two electrodes were cold or all three hot. The purpose of this test was to demonstrate beyond all cavil the falseness of the assumption that *rectification* plays in any way an important or essential part in the operation of the three electrode audion.

Fig. 3 of the above mentioned patent No. 824,637 shows the next obvious step in the evolution of the audion i.e., doing away with the unnecessary battery for heating one of the electrodes. It was obvious, of course, that so long as the "B" battery was properly connected so that its positive pole led to the cold electrode, there was no necessity or advantage in heating this second electrode. The audion in this form—one hot and one cold electrode, and the "B" battery connected with this positive terminal to the cold electrode, was used for some months, and shows a sensitiveness as a detector, superior to that of the electrolytic detector, and far superior to that of the Fleming valve rectifier. We had, thanks to the "B" battery which was invariably employed, a genuine *relay* or *trigger action* of the high frequency oscillations upon the normal current-carrying ions, or electrons, passing between the two electrodes.

As everyone familiar with incandescent lamp or X-ray bulb phenomena knows, the proportions of current passing between two electrodes therein (one or both being hot) carried by ions or carried by thermions, depends chiefly upon the degree of exhaustion of the bulb. The gradual preponderance of thermionic conduction over ionic conduction has been gradually increasing as the art has progrest with improvements in pumps, knowledge of the fine points of exhaustion, etc. Thus it has always been impossible to lay a finger upon a certain date or upon any audion type of device, and say, "This marks the distinction between an ionic, or gaseous detector, and a thermionic detector." It is in fact impossible to prove even to-day when audions or oscillions are exhausted to the highest degree that the conductivity is *entirely electronic.*

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In the spring and summer of 1906 I had opportunity to spend a good deal of time on the audion problem, and was always seeking to improve its efficiency. Keeping in mind then the disadvantage of directly connecting the high frequency circuit with the local circuits, and harking back to the four electrode gas-flame detector above mentioned, I sought to keep one electrode of the high frequency circuit distinct from the two electrodes of the local current. Obviously the most simple experiment was to *wrap a piece of tinfoil around the outside of the glass bulb and connect this to one end of the secondary transformer of my receiver.* The other end of the transformer was connected to the filament, it being obviously unnecessary to employ four electrodes to effect the end desired. Exactly this arrangement, with the third electrode around the outside of the bulb, is shown in Fig. 3 of patent No. 841,386, which was filed in August, 1906. It will probably be recalled that this outside electrode has been very recently "re-discovered" with considerable eclat and acclaim! I also at this time wrapt a coil of wire around the bulb, connecting one end of this to the antenna and the other to the ground, seeking thus to effect the ionic conductivity between the inner electrodes by electro-magnetic influence from the high frequency oscillations passing around this helix. See Fig. 4, patent No. 841,386.

The arrangement of the external tinfoil belt may therefore be called the *parent of the third electrode.* It showed a decided improvement in the sensitiveness of the detector, as I had anticipated. I recognized that by this arrangement I had in effect a condenser between the filament connection and a hypothetical third electrode, which consisted of the conducting layer of gas located on the interior walls of the bulb, the other arm of this condenser being the tinfoil belt outside the glass. I recognized also that this was a very inefficient and indirect way of impressing the effect of the high frequency oscillations upon the conducting medium between the filament and plate. The third electrode should therefore be placed inside the bulb. I immediately instructed McCandless & Company to make such a bulb. The first type of this third electrode was in the form of a plate, located on the opposite side of the filament from the "B" battery plate. This arrangement showed the increased efficiency and sensitiveness anticipated. It is shown in Figs. 2 and 4 of patent No. 841,387, filed October, 1906. This is the audion amplifier and telephone relay patent. Fig. 2 of this patent is interesting as showing also for the first time a third battery ("B") in the external circuit between the third electrode and the filament. T in this figure represents the high frequency transformer.

In Fig. 4, where this battery is omitted, is shown for the first time the grid stopping condenser C. In studying this type of three electrode bulb, I recognized that the third electrode was not yet in its most efficient position. It should be placed directly in the path of the ionic or thermionic stream, passing from filament to plate, where the high frequency electric charges imprest on the electrode could best affect this stream. But if placed directly between two electrodes, a solid plate, of course, would constitute practically a complete barrier. Hence I devised the *grid* or *perforated screen structure.* In fact, the first audion where the third electrode was placed between the filament and plate utilized the wire bent in grid form which is familiar to every amateur or user of the audion prior to 1914.

This type of third electrode so located was so marked an improvement over the preceding three-electrode bulb, that shortly thereafter a patent was applied for on it. This was issued in February, 1908, No. 879,532. See Fig. 1 where the complete receiving arrangement and the grid audion is clearly shown.

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The audion remained in this form for six years. During that time its merits became gradually recognized in Europe as well as here, and it was not long before the little stranger was, like its predecessor, the two electrode brother with "B" battery, adopted into the Marconi family, and like its predecessor re-christened the "Fleming Valve." As soon as the audion amplifier had been developed for long distance telephone service by the engineers of the Western Electric Company, and installed on most of the long distance lines of the A. T. & T. Co., we find certain English publications adopting it also into the Fleming valve family; and now after the three-electrode device has demonstrated its utility as a radio transmitter of absolutely constant undamped waves and made possible transoceanic telephony, we learn that this big brother which I first named the Oscillion, is also the Fleming valve. Not even "junior" or "senior" is used to distinguish one from the other in this rapidly growing Fleming valve family.

The art founded on the three-electrode audion has grown of late years with enormous strides. The great war has produced a tremendous intensity of development for various military purposes and it cannot be disputed that the engineers of the Western Electric Company have taken a foremost position, and much of the present-day efficiency of the detector and amplifier has been due to their efforts, spurred on as they were by the difficult demands and specifications of our Signal Corps officers and engineers. It is estimated that there has been constructed for the U. S. Signal Corps during the war between 200,000 and 300,000 audion and amplifier bulbs, and at least 50,000 small oscillators. In Great Britain wartime production has probably equaled or exceeded the above; while in France we are informed that during the last two years of the war, the audion production has averaged about *5,000 per day!* The French bulb is particularly interesting as being efficient and suitable in all three uses, detector, amplifier and oscillator. For such purposes, of course, a compromise in efficiency was inevitable, and maximum efficiency in either of these three branches has been somewhat sacrificed.

Considerable discussion has lately arisen as to the first use of the audion as an oscillator or source of alternating current. This matter is now being thrashed out in a multiple interference procedure in the U. S. Patent Office. But the evidence so far indicates that the writer's application of this property of the audion in the spring of 1912, marked the first use of the audion as a generator of undamped electrical currents. In view of recent developments, particularly the highly interesting announcements of President Vail of the A. T. & T. Co., regarding multiplex wire telephony and telegraphy over a single conductor pair, it may be prophesied that the application of the audion as a generator of alternating currents will be fully as useful as that of detector and amplifier.

There is, in the writer's opinion, no doubt but that if the development of radio is not now made a Government monopoly, it will not be long before commercial trans-oceanic wireless telephony will be effected. This work, whether the generator be a bank of oscillions or a high frequency alternator, will be made possible only thru the extraordinary amplifying properties of the audion, when used as telephone repeater or relay.

The simplicity of the oscillion transmitter in small sizes, coupled with the extraordinary sensitiveness of the "zero beat" audion detector or amplifier of received high frequency energy, warrants the belief

(*Continued on page* 831)

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LATEST STYLE IN FLASHLIGHTS.

(*Continued from page 767*)

the entire set of meter dials are instantaneously photographed on a film. When the meter-reader gets back to the office, the exposed roll film is removed from the camera and a new roll inserted. The film is then developed and the bills made out from the record photographed thereon.

Down on the farm we find another interesting use of the flashlight, tho Uncle Josh will swear that the old barn lantern is much better, and this is in the *testing of eggs* for fertility and freshness. Several attachments have been produced, or one can easily be made from a piece of cardboard, aluminum or tin, in the shape shown in the accompanying illustration, Fig. 7, so that a strong beam of light is thrown against the egg, as it is placed in the opening in the candling screen. In this connection it is interesting to note that by holding a flashlight bulb against the hand or against the finger that it is possible to locate foreign bodies in the finger. The illumination is very intense, and will act almost like an X-ray.

Figure eight shows a doctor's *head lamp* fitted up in an emergency or for regular use from a pocket flashlight. The battery is connected with a piece of flexible twin-cord to the lamp bulb, which is preferably mounted in a small receptacle secured to a piece of fiber, and which in turn is wired or sewed to a strip of elastic webbing. A small buckle can be secured to the free ends of the webbed band, so as to hold it in place on the head in any desired position. A polisht nickel reflector is held in place by the lamp when screwed into the socket, as indicated.

Another clever use for flashlights is in the form of a *desk signal*, and this scheme is outlined at Fig. 9. It has been tried out with great success in several offices. A diagram is given for a three-wire return call system. The beauty of the flashlight call system is that it does not give such a nervous shock to a person as the ordinary buzzer or bell, and it is also very simple and quick to install. Any one can install such a signal system in a few minutes' time. Ordinary bell wire or some flexible lamp cord is used for connecting the two stations together, and the internal connections made to the flashlight battery are clearly shown in the diagram. Where two or more flashlights are used on one desk, the lenses may be of different colors, so that the party calling is indicated more quickly.

Figure ten shows one form of *electric clocklight*. Of course, most ordinary mortals find the pocket flashlight very useful about the bedroom, and invariably keep one under their pillow, so that it is only necessary to flash it on the clock or watch and ascertain the time whenever desired, but in some instances it proves more convenient or desirable to have the lamp bulb mounted on the clock base as here shown. Those desiring to utilize this scheme can easily do so, and all that is necessary is the ordinary flashlight, the proper length of flexible twin-cord and a push-button, preferably of the pear-shaped variety.

Figure eleven illustrates one out of about ten thousand possibilities in electric flashlight advertising and tie-pin novelties. The illuminated "stove pipe" and shirt bosom shown, were not merely sketched by the artist, but were actually used for several years in New York City, and tickled the heart of many a youngster as well as grown-up. The man fitted with this illuminated silk hat and shirt bosom was quite a common figure on Broadway at one time, and created one of the most novel surprises progressive advertising ever initiated. Needless to say, the best results are obtained with such an arrangement when the lights are flashed on and off at short intervals. In the present case the hat became illuminated first and then the shirt bosom, the arrow in the front of the hat sign causing the onlooker to glance downward invariably, and at that psychological moment,— lo and behold! the shirt bosom blazed forth in all its red-and-white-striped-glory, to the effect that "Killem-quick's" whisky was the only stuff that had the "punch"—it did'nt say it was a deadly punch, to be sure.

The illustration at Fig. 12, shows a very ingenious and most useful instrument utilizing the flashlight principle and known as the *inspectoscope*. As the illustration shows, the inspectoscope comprises a tube either of fixt length, or else made telescopic, at the lower end of which there is a mirror placed at an angle of 45 degrees, while at the upper end of the tube a small flashlight case and its battery are mounted. The lamp at the bottom of the tube receives current thru the metal tube, and the other side of the circuit is completed thru a single insulated wire leading up to the flashlight battery, the button switch on the battery case being used to light the lamp. This instrument has been found extremely efficacious in reading name-plates on motors and other machinery where they happen to be in inaccessible locations, such as close to a wall, etc. Many other practical and ingenious uses of the flashlight will suggest themselves to the reader, and it is doubtful if there has ever been any one invention in the electrical field that has become more universally adapted than the pocket flashlight.

POPULAR ASTRONOMY.

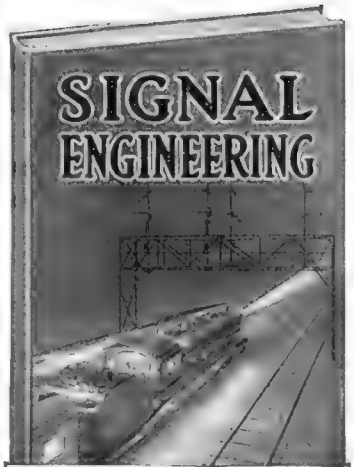
(*Continued from page 781*)

the planet is best seen. Its flattening at the poles, which is nearly ten per cent of its equatorial diameter gives it a decidedly oval appearance at this time. Ordinarily one of the hemispheres of Saturn is partly or entirely concealed by the rings so that the oblate form is not so noticeable. After the temporary disappearance of the rings in 1920 the earth will pass from a position below the rings to one above them. The northern surface of the rings and the northern hemisphere of Saturn will come more and more into view after this date, the southern surface of the rings being invisible and less and less of the southern hemisphere of the planet being seen until the rings once more approach their widest opening about seven years later. From this time on until the earth is once more in the plane of the rings, after another quarter revolution of the planet, the elevation of the earth above the rings becomes less and less and the width of the system decreases in proportion to its length. It was this change in the tilt and visibility of the rings that so perplexed Galileo when he attempted to make out the nature of these appendages of Saturn with his crude telescope of insufficient magnifying power. So great was his bewilderment when the rings finally disappeared that he cried out in despair that Saturn must have swallowed his children, according to the legend. He finally became so exasperated with the results of his observations that he gave up observing the planet. The true nature of these appendages of Saturn remained a mystery until Huyghens solved the problem in 1655, some time after the death of Galileo.

In addition to the rings, Saturn has nine satellites named in the order of their distance outward from the planet: Mimas, Enceladus, Tethys, Dione, Rhea, Titan, Hyperion, Iapetus and Phoebe. The last mentioned satellite was discovered by W. H. Pickering in 1899. It aroused great interest at the time because it was the first satellite to be discovered with "retrograde" motion in its orbit. Two satellites of Jupiter since discovered revolve in the same direction around their primary.

The satellites of Saturn approximate to

(*Continued on page 823*)



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SKINDERVIKEN TRANSMITTER BUTTON

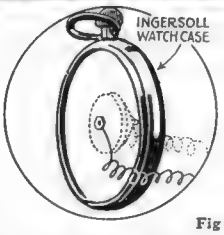


Fig 1

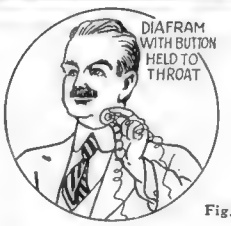


Fig. 2

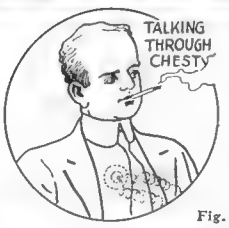


Fig. 3

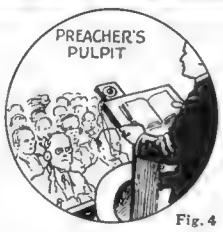
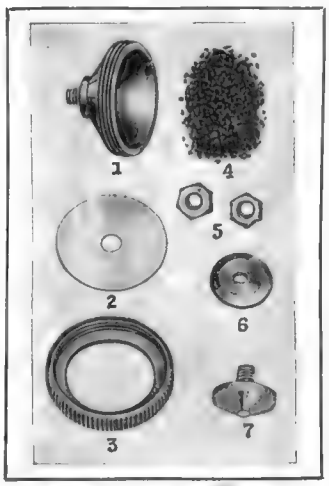


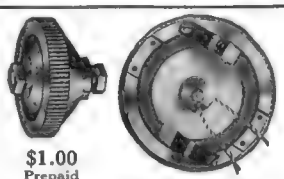
Fig. 4

THE SKINDERVIKEN TRANSMITTER BUTTON presents the latest advance in microphones and marks a revolution in transmitter construction. It works on an entirely new principle, takes up practically no room, and marks the end of all telephone transmitter troubles.

The SKINDERVIKEN TRANSMITTER BUTTON can be placed in any position and it will talk loudly and distinctly and is at the same time extraordinarily sensitive. It was primarily designed to replace the old damaged or burnt-out transmitter. Simply unscrew and remove the telephone transmitter front, disconnect the two inside wires, unscrew and remove the bridge and the old electrode. There remains only the diafram. These wires are then connected with the Skinderviken button, the latter screwed to the diafram, and after screwing the old transmitter housing together again, the telephone is ready for work.

ELECTRICAL EXPERIMENTER readers will be particularly interested in all the different experiments that can be performed with the Skinderviken Button. Fig. 1 shows the Skinderviken button attached to the back of an Ingersoll watch case. When speaking towards the inside of the case, it will be found that the voice is reproduced clearly and loudly.





$1.00 Prepaid

This shows how Button is attached to ordinary telephone transmitter.

Fig. 2 shows another interesting stunt. By attaching the button to a tin diafram about the size of half a dollar, and by holding the diafram at the side of the throat, as shown, speech can be transmitted with surprising clarity. Fig. 3 illustrates the same arrangement placed on the chest as shown. In this position the transmitter will talk clearly and loudly. Fig. 4 shows an arrangement whereby the Skinderviken button is attached on a thin wood board at the preacher's pulpit. His voice is clearly transmitted so that people hard of hearing can readily hear the sermon. Fig. 5 shows how a very sensitive Detectophone can be made by placing one of the buttons in the center of a lithographed cardboard picture, so that only the small brass nut shows. The large surface of the picture acts as a big diafram, and the voice is well reproduced. Fig. 6 shows an interesting stunt, whereby a hole is drilled in the side of a thin glass water-tumbler; the sides of the glass thus acting as a diafram, the voice is clearly transmitted. Fig. 7 shows a simple match box Detectophone. The Skinderviken button is concealed inside of the box, only the small brass nut showing on the outside. This can be camouflaged as well. This device talks well. Fig. 8 shows how to transmit phonograph music at a distance merely by drilling a small hole in the phonograph arm and attaching the Skinderviken button; a very favorite experiment with all experimenters.

We have such unlimited confidence in the Skinderviken Transmitter Button that we make the following remarkable offer. Send us one dollar ($1.00) for which we will mail one button prepaid. If you do not wish to keep it, return it within five days and your money will be refunded. Boys! send stamp for booklet No. 4. It gives diagrams and experiments using the Skinderviken Transmitter Button, and prices of telephone equipment.

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Fig. 5

Fig. 6

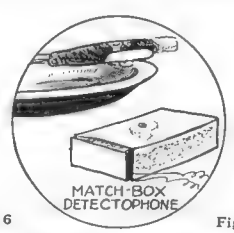

Fig. 7

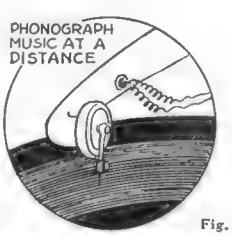

Fig. 8

Skinderviken Telephone Equipment Co. Address us as STECO, 2118-2136 N. Clark St., Chicago, Ill.

POPULAR ASTRONOMY.

(*Continued from page* 821)

those of Jupiter in size and exactly equal them in number. The largest, Titan, is three thousand miles in diameter and can be seen with the smallest telescopes. With a four-inch telescope five of the satellites can be easily found tho they are not as interesting to observe as the satellites of Jupiter because they are on the average four hundred million miles more distant. The time they require to make one journey around Saturn varies from nearly twenty-three hours for Mimas, the nearest, to approximately five hundred and twenty-four days for Phoebe, the most distant.

Like Jupiter, Saturn is marked by belts parallel to the equator tho they appear more indistinct than those of Jupiter on account of the greater distance of Saturn. Saturn also resembles Jupiter in its physical composition which is largely, if not entirely, gaseous and in the extremely short period of rotation on its axis which is approxmately ten hours. In more ways than one Saturn is a very unusual planet. In addition to possessing an enormous ring system it is the lightest of all the planets, its density being only sixty-three hundredths that of water, and it is the most oblate, its

Fig. II Shows (On a Scale Reduced Ten Times From That of Fig. I) the Orbits of the Outer Satellites. Even on This Reduced Scale It Is Impossible to Represent the Orbit of Phoebe, the Most Distant, Which Is Three and Six-Tenths Times More Distant Than Japetus.

flattening at the poles amounting nearly to one-tenth of its diameter. Its equator is more highly inclined to its orbit than is the case with any other planet, not even excepting the earth and Mars. For this reason its seasonal changes are very great, in marked contrast to Jupiter whose equator lies very nearly in the plane of its orbit. Since Saturn is so far away from the sun that it receives only one-ninetieth as much light and heat per unit area as the earth, its outer gaseous surface must be extremely cold unless considerable heat is conveyed to the surface from within its hot interior.

Prof. Lowell concluded from certain observations made at Flagstaff, Ariz., that Saturn is composed of layers of different densities and that the inner layers are more flattened at the poles and rotate faster than the outer layers. Marked variations in the color and brightness of the ball of the planet have been noted from time to time. In 1916 observers of Saturn described the planet as pinkish-brown and conspicuously darker than the brighter portions of the rings. The ringed planet may now be found in the constellation of Leo not very far from the star Regulus at the end of the handle of "The Sickle." It is more than twice as bright as Regulus and of a yellowish tinge. As it was in opposition to the sun on February 14, it is now most favorably placed for observation, being visible all thru the night.

"THE BORDER WIRELESS" AND "THE HUN WITHIN."

(*Continued from page* 768)

cause of his hatred for Prussian autocracy and who has become intensely American. His son Karl, however, whose nature is cold, is pro-German despite his father's protests, and after being educated in Germany he returns home just before Germany involves the world in war.

Near the Wagner home lives an invalid, with her daughter, Beth, a charming patriotic girl. The girl's father at his death begs Wagner to watch over Beth and she seems devoted to Karl; he offers no protest. Frank Douglas, a schoolmate of Beth's, is devotedly attached to her and her seeming preference for Karl causes him great anxiety. Beth is living in the Wagner home and there meets Grippen, a German spy, who is assisted by Leone, known as the "Lynx," a German Secret Service agent, and Krug, a spy, who is a sailor on a transport. Douglas enters the United States Secret Service as operative and is trailing Leone.

At dinner, young Wagner takes the oath binding himself to the service of the Kaiser. It is determined by Grippen and his agents to destroy American shipping and when war is declared by the United States against Germany, Grippen resolves to destroy transports conveying troops to France. Beth is seated in an easy chair one night when she overhears Leone tell Karl that Krug has planted a bomb, secreted in a thermos bottle, on board a transport, and that it has been timed to explode at midnight on the date of sailing of the vessel.

Shocked at this proof of the perfidy of the man she believed she loves, Beth upbraids Karl, whereupon he binds and gags her and then conveys her to the mountains where Grippen's lair is located. Douglas is trailing the spies persistently and they decide to get rid of him. He is kidnapt and when his senses leave him, the spies throw him out of an automobile into a creek. This revives him and he makes his way with difficulty to the spy rendezvous where he discovers that Beth is a prisoner.

He eludes the guard and obtains access to Beth who tells him of the attempt to be made to destroy the transport. He has a fierce battle with the guards, but manages to place Beth in an automobile and start at full speed to warn the authorities of the transport's peril. They reach the Wagner home after Karl's departure and when the father hears of his son's traitorous conduct he is frantic with rage. The *telephone* having been put out of commission by Karl, Beth leaves for a *wireless station* near by.

Karl returns home and when his father upraids him, he shoots him. A mob gathers outside and Karl is about to be lynched when a troop of cavalry saves him. He and Grippen are taken in custody for trial. Meanwhile Beth and Douglas reach the wireless station and altho the bomb is to explode at midnight, the operator at ten minutes of that hour, has failed to get in touch with the transport.

Krug is about to jump overboard to escape the fate he and his confederates have prepared for the troops aboard the transport, when Beth's wireless message is received and he is apprehended. The bomb is discovered at one minute of twelve o'clock and it explodes as it is hurled into the water. The elder Wagner recovers from his wound and Beth and Douglas plight their troth.

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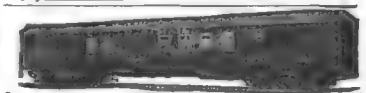

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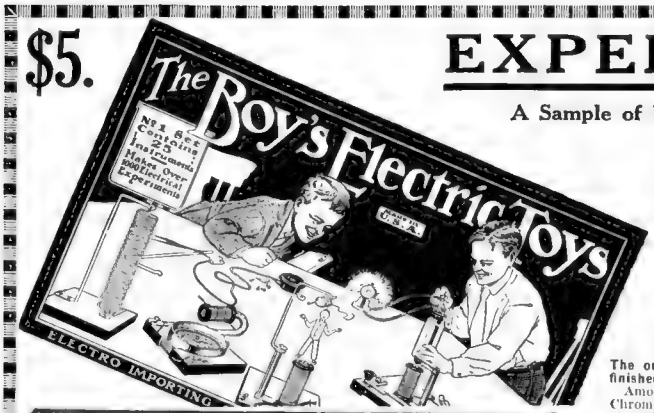

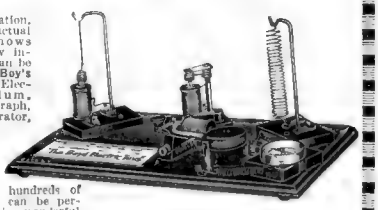

This illustration, made from an actual photograph, shows only a very few instruments that can be made with the **Boy's Electric Toys**: Electric Pendulum, Electric Telegraph, Current Generator, Electric Dancing Spiral, Galvanometer, Space does not permit us to show the hundreds of experiments that can be performed with this wonderful outfit.

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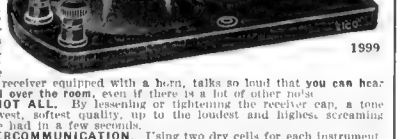

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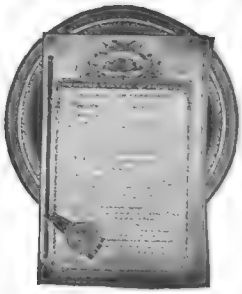


Edited by H. GERNSBACK

In this Department we publish such matter as is of interest to inventors and particularly to those who are in doubt as to certain Patent Phases. Regular inquiries address to "Patent Advice" cannot be answered by mail free of charge. Such inquiries are publisht here for the benefit of all readers. If the idea is thought to be of importance, we make it a rule not to divulge all details, in order to protect the inventor as far as it is possible to do so.

Should advice be desired by mail a nominal charge of $1.00 is made for each question. Sketches and descriptions must be clear and explicit. Only one side of sheet should be written on.

NOTICE TO CORRESPONDENTS

Questions on Patent Advice are answered in this department every month, and naturally each question must take its turn. We have received so many letters during the past months that it is absolutely impossible for us to answer them all in the "Experimenter." Thus, for instance, the answers appearing in this issue are of letters going back as far as July, 1918. We would therefore urge our correspondents to bear this in mind, and if an answer is wanted quickly, correspondents should make themselves acquainted with the rules printed above.

Resistance Measuring Instrument.

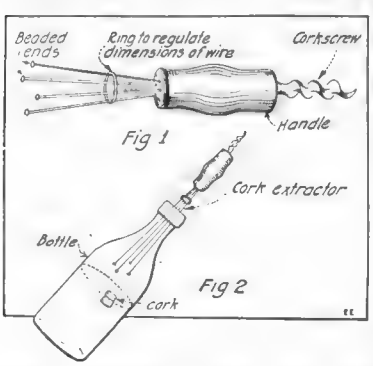
(305) John E. Wheatley, Roachdale, Ind., has invented a device for measuring resistance directly. The device was designed to replace the voltmeter-ammeter resistance circuit and Wheatstone bridge for measuring distances. Our correspondent states the case correctly that both of these methods are intricate and usually require some calculation and too much time. Our correspondent further discloses the construction of his instrument which has a scale working like an ordinary meter, so that the resistance can be read off directly without the necessity of calculation, etc.

A. While there are direct reading ohm-meters on the market, the device in question certainly has unusual merit; and if it can be marketed cheap enough, say for anywhere from fifteen to twenty dollars, we believe that there is a big market for such an instrument. We think a patent can be obtained.

Combination Cork Screw and Cork Extractor.

(316) Dan Lingo, Huntington, Ark., submits an idea of a combination cork screw and cork extractor, and our illustration shows the idea, which consists of a handle, cork screw on one end and beaded wire ends with the ring, at the other side. The *modus operandi* is shown in Fig. No. 2. With a device of this kind as is well-known the cork can be extracted very readily once it was pushed inside of the bottle.

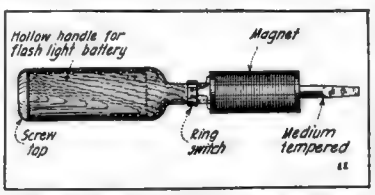
A. The idea is a good one, and while there is of course nothing new as far as the two utensils are concerned, the combination of the two into one is undoubtedly a good feature. To our mind, if the wires could be pushed inside of the handle, out of the way, it would be an added feature of merit. We believe a patent can be obtained on a device of this kind.



Clever Combination Cork Screw and Cork Extractor.

Electro-Magnetic Screw Driver.

(317) Vernan Clements, Elmwood, Nebraksa, submits a clever device which he terms an "electro-magnetic screw driver." The sketch shows the idea which consists of a screw driver with electro-magnet, the latter being energized by a battery held in the hollow handle. Current is supplied to the magnet by means of a switch ring. Our advice is asked.



An Electro-magnetic Screw Driver with Self-contained Battery in Handle.

A. This at first blush seems a good idea, and if the screw driver is only used for a few seconds at a time, which it probably would, it possibly will work satisfactorily, for the magnetism is only used to pick up a screw and hold it long enough until the latter is set; then the current is *supposed* to be turned off. We say *supposed*, but it probably never is. The user would most likely forget to turn off the switch, with the result that the small battery would run down very shortly, and this is where the trouble lies. Otherwise, however, we see no fundamental objection. We are not quite certain if a patent can be obtained, as it seems to us we have seen a similar idea once before. Search in the patent office would, to our mind, amply repay our correspondent.

Trolley Wheel.

(308) Russell A. Adams, Battle Creek, Mich., has sent sketch and description of a trolley wheel.

U.S. PATENTS

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which is supposed to stay on the wire, a solution often thought of by inventors. Our correspondent tries to overcome the objectional feature of a wire jumping trolley by using two side shoes, pressing against the upper circumference of the trolley wire. Several other ingenious points are also shown in this idea.

A. Nothing fundamentally new is contained in this idea, and our opinion is that inventors should steer clear of trolley wheel improvements. There are literally thousands of such patents, and not one of them to our mind has ever been adopted by any of the traction companies. For many reasons the electric railway people seem to think that the old copper wheel is still the best. It is the same as the old-fashioned telephone receiver, which has been on our telephones for the past generations. While thousands upon thousands of patents—real good ones, too—have been issued, for some reason or other, the old receiver is still on the job and probably will be for many years to come. Our advice to inventors is to leave trolley wheels alone, and guide their ingenuity and inventiveness into other and more productive channels.

FIVE CONVERSATIONS OVER ONE WIRE.

(*Continued from page 766*)

thus gives the voice wave an identity of its own and at the end of the journey the waves are sorted and directed into their proper channels to be delivered as formed originally.

But how do these five telephone currents pass over the circuit simultaneously without becoming all mixed up, you ask. "Imagine, for example," said Mr. Gherardi, "a composite photograph, in which each of five subjects is photographed in a *different* color, one red, one blue, one green, one orange and one violet. In the composite picture the colors as well as the features are blended, but when you look at it thru colored glasses, each picture may be distinguished from the others. Thru red glasses the red photograph is shown, thru blue glasses the blue photograph comes up most clearly, and so on."

There are several other analogies in physics, which will bring out the working action of the control and filtering of these "carrier" currents. First there is ordinary sunlight. A beam of this white light is made up of a composite bundle of six primary colors, each color representing a different and distinct vibration frequency of the ether particles. Thus we find that the beam of white light is first produced or formed in the sun, where many different chemicals are in a state of combustion—each with a spectrum color of its own; all combine and form white light—the sun's rays. These composite rays, combining six predominating ether wave frequencies or colors—red, orange, yellow, green, blue, and violet—(not to mention a host of other intermediate shades of colors with their corresponding and distinct frequencies*), are transmitted thru the intervening ether to our earth. Now, if we take a glass prism, see figure "A," and pass a beam of sunlight (white light) thru it as shown, then we will see the composite colors corresponding to the different frequencies projected on the sheet at the left, in the order named.

A second phase of this experiment, familiar to every high-school boy, is that of the "synthesis of light", illustrated at figure "B". Here we have a beautiful analogy to the multiplex telephone which can be easily demonstrated. A beam of white light (sunlight) of many frequencies, is past thru the first prism, but as it emerges after being filtered by prism No. 1 the separated frequencies (colors) are recombined by prism No. 2, and formed into a "composite medium of transmission", such as that which traverses the telephone wire when the five telephone currents are applied to it.

A simple diagram for duplex telephony by the Squier's system is here shown. Major-General G. O. Squier proposed his multiplex telephone and telegraph system in 1911. He applied wireless currents to wire systems and thus it was called Squier's "wired wireless". His invention had the

* See Wood's "Physical Optics", page 11, for table of different wave lengths (inverse of frequencies) of various colors.

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germ of the present multiple telephone in it. There were a number of high frequency generators (radio telephone transmitters) connected across the common telephone system, one way being shown, and a corresponding number of tunable radio receiving stations connected across the same pair of wires. Thus each radio frequency current (30,000 cycles and higher, so as to be inaudible) would be picked off the line and past thru its own particular and properly tuned receptor. The universal operating characteristics of the audion type of vacuum relay as devised by Dr. Lee de Forest solved the problem of making such a system adaptable to the use of the public.

Credit for the pioneer work accomplisht by these men is given in the signed statement announcing the successful solution of the multiplex telephone problem addrest to Hon. Albert S. Burleson, Postmaster General, Washington, D. C., by Theodore N. Vail, President of the A. T. & T. Co., on December 11, 1918, which includes the following citation:—

"From the earliest days of both the telephone and the telegraph, there have been almost numberless attempts by inventors, scientists, and engineers to develop methods for the multiplex transmission of messages. It was while working on the problem of multiplex telegraphy that Dr. Bell had his first conception of the structure of the original telephone. Now the organization, which is continuously working to perfect the telephone and to extend its usefulness, has accomplisht not only multiplex telephony, but also multiplex telegraphy and has solved the telegraph problem upon which Dr. Bell was working over forty years ago.

"While heretofore no substantial practical results had been obtained notwithstanding the efforts which have been directed to this problem, some proposals made by the earlier workers in this particular field have naturally proved suggestive in the successful solution of the problem. I have in mind particularly a suggestion made by Major General George O. Squier, Chief Signal Officer of the United States Army, about ten years ago and which at the time attracted very general attention.

"Furthermore, while working in entirely different fields and with a different objective, Dr. Lee de Forest a number of years ago invented a wireless device known as the **audion** which by our improvements and adaptation we have made an important part of our system."

We all know, or at least have heard, that there are ranges of frequencies, both electrical and mechanical, that are beyond the limits of perception by any of our five senses. But telephone engineers have found out that currents of high frequency, for example, obey the same laws as currents of low frequency, and they have found out further that these high frequencies have a particular liking for circuits specially dimensioned to receive them, and that each particular high frequency, or range of high frequency, if given a chance to choose between a number of different circuits, will select the one best adapted to its needs, and travel down it in preference to all other circuits.

Now it is possible by the multiplex method to utilize a single pair of wires for five conversations, while two pairs of wires, which heretofore had a maximum of three conversations with the aid of the "phantom," may now be multiplexed to carry *ten* simultaneous conversations. This amounts to an increase of more than *threefold* in the telephonic carrying capacity of the wires as compared with the best methods previously known to the art, and an increase of *fivefold* in the capacity under conditions where the phantom circuit just alluded to is not employed.

The new multiplex system makes use of alternating currents whose frequencies oc-

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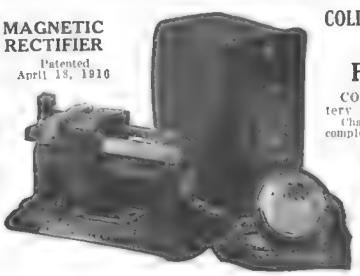

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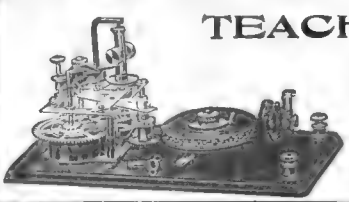

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cupy a range between the frequencies of the ordinary telephone currents, which are those of the human voice, and the lowest frequencies which are used in wireless communication. This frequency range has not heretofore been commercially used. It is interesting to note that under favorable conditions the whole range is audible to many and the lower part of the range is audible to any one with normal hearing. It is found that frequencies within this range are high enough to be used as "carriers" of ordinary telephone currents and yet with proper arrangements can be transmitted over long telephone lines without the large transmission losses and large interference between circuits which would be brought in by higher frequencies.

Each *additional* circuit in the new system makes use of some frequency within this range. At the sending end of each circuit the ordinary telephone currents are made to modulate this "carrier" frequency by means of an audion tube so that the amount of carrier frequency sent out on the line varies with the amplitude of the ordinary telephone currents. At the receiving end the carrier current is put into a demodulating circuit, which includes another audion, and which then gives out the original telephone current.

The different circuits are kept separate at each end by inserting in each circuit a combination of impedances which make up an electrical "filter." This transmits the range of frequencies peculiar to that circuit and stops all other frequencies. An important difference should be noted here between this system and wireless systems in that in wireless working it has been generally sufficient to send and receive in "tuned" circuits. In the multiplex system, however, tuned circuits would not be sufficient since each telephone channel occupies a range of frequencies of about 2,500 cycles and any circuit tuned to these comparatively low frequencies would be too selective to receive such a range in the proper manner.

Vacuum tubes (audions) are used in the modulating and demodulating circuits and are also used as amplifiers in the transmitting and receiving branches and at intermediate points along the line where necessary to prevent the currents from becoming too highly attenuated.

In regard to the increased telegraphic capacity afforded, Mr. Gherardi stated:—"The advantages of the system when applied to telegraphy as well as to telephony were clearly shown in our tests. We found that we can combine our system with the printing telegraph so as to secure the full advantages of the latter and the full advantages of the multiplex system in reducing wire requirements. Using our multiplex system with the ordinary hand operated telegraph instrument, connected with a telephone circuit, we can send from 1,500 to 1,600 words in a minute. When the multiplex system is connected with the printing telegraph, we can send from 4,000 to 5,000 words in 60 seconds."

GOLD AND SILVER LOCATED WITH SOUND WAVES.

(*Continued from page 769*)

the ore bodies. For example, if the distance between the record made on the oscillograph, R—O_1, by the transformer on depressing the key K, and the record made by the arrival of the sound directly along the line Q, which would be the first sound to record itself after the depression of the key, is five inches—then *one inch* on the photographic record corresponds to *one mile* in distance, since drill hole A is located five miles from the drill hole D. This establishes the standard of measurement on the oscillograph.

Now for example, if the length between the key depression record and the record made at D, by the sound reflected at P is

9 inches, it is evident that the sound proceeding from O and reflected at P, and finally reaching D, has traveled 9 miles. If, again, the length between the key depression record on the oscillograph, R—O_1 and the record made by the sound sent out from O, and reflected back from J, Fig. 2, is 8 inches, then it follows that the ore body I, is located approximately 4 miles from the point A. The ore deposit therefore lies at the intersection of the sphere described about O, with a radius of 4 miles, with the sphere described about D_4 with radius 9 minus 4, i. e., 5 miles.

There are a number of ways outlined in Prof. Fessenden's description of his invention, which may be utilized for locating the exact point on the line of intersection where the ore bodies are located. As he points out, it is possible to find this point of intersection by merely determining the time elapsing between the key depression record and the echo record made by reflection, say at J, Fig. 2, together with a determination of the direction from which the echo is received. The extent of the ore body can be obtained by readings taken by transferring the oscillator O, to the other drill holes and taking readings on the oscillographs on sending out sound waves at these drill holes.

Prof. Fessenden also describes special apparatus for determining accurately the direction of the sound received, which employs two of his oscillators connected together, differentially. This scheme of locating ore deposits may sound a little hazy or improbable at first glance, but the theory can be readily tried out by means of a small siren and a reflector or two, together with some auxiliary apparatus which any electrical experimenter can readily devise, the difference in such an experiment being that the sound waves will then be detected, reflected or refracted in air, whereas in applying this system to the locating of buried ore deposits, the sound waves have to travel thru rock and soil as well as water, in which mediums the velocities of sound propagation varies considerably. The velocity of sound propagation thru water is about four times as great as that thru air, or approximately 1,100 feet per second for air and 4,700 feet per second for water.

BOOK REVIEW.

(*Continued from page* 804)

teries, theory of telephone and field buzzer circuits —with many diagrams. The section devoted to radio is practically a reprint in whole from "Radiotelegraphy" as published by the signal division of the U. S. Army—but which, of course, must needs finds its place in a work of this kind, and serves to cover all that need be known by a radio man of the signal corps.

Two closing chapters are devoted to methods of handling traffic, various codes—secret ciphers—Wigwagging—Signaling with lamps—searchlights—sun or heliograph and the Semaphore. Signal troops in the field—Laying out camps, Map reading and the general function that the Signal Corps fills in both war and peace—general field duty and coast defense.

The volume is dedicated to Major-General George O. Squier, Chief Signal Officer, U. S. Army, whose assistance made the book possible. It is an ideal manual and has all the usually needful information possible incorporated between its covers and should prove an essential to all enlisted men seeking promotion as well as to the layman who is interested in this important branch of the Army's work.

THE BLUEJACKET'S MANUAL, by Lieutenant Norman R. Van Der Veer, U. S. N. Cloth covers, 808 pages, profusely illustrated, size 4¼ x 6¼ inches. Price $1.00. Publsht by Edwin N. Appleton, New York, 1918.

This work is the official reference and study manual used by all naval men. The various operations and practices in naval life are thoroly described and suitably illustrated. The treatment is divided into several parts and again sub divided so that by reference to the special indexes given in the front of the volume, the student can readily locate certain sections of the text concerning special positions, such as those concerned with ordinary seamen, subjects which chief petty officers should know, and the subjects which men of special ratings should know. This work has been officially past by the Secretary of the Navy.

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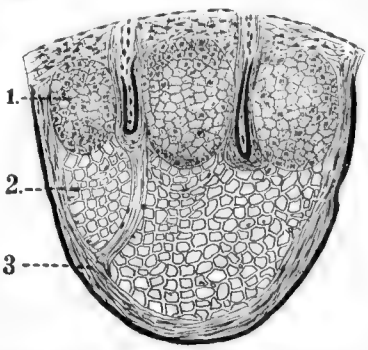
SEARCHLIGHTS OF THE DEEP.

(*Continued from page 772*)

Each light organ contains a number of tiny glands which secrete the light-producing fluid and all glands empty into a con-



Luminous Organ: (1) Lenses Which Concentrate the Light. (2) Glands Which Secrete the Lighting Fluid. (3) Reflector, in Back of Which Is Situated the Black Opaque Membrane.

cave cavity. The action of this fluid can be likened to the effect of the liquid in a wet battery on the electrodes. It acts as a stimulus. A further proof of the chemical action of some of these organs can be found on certain fish which only produce light when the secreted fluid is in contact with the water. Light can therefore be given off after the fish has died. Other species produce their light only thru intercellular action; this of course does not constitute a chemical reaction.

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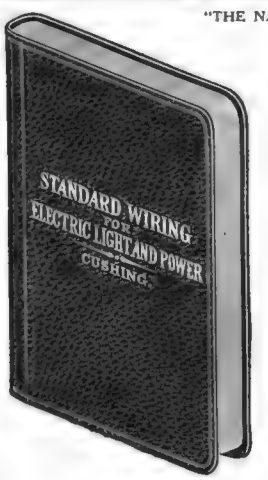

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mented tissue, which reflects the light outward. An opaque tissue situated just behind the reflector prevents the light from entering the body.

Lenses, which are often present, tend to concentrate and throw the light forward. These lenses consist of a transparent cartilage covered with a transparent skin. In addition some fish even have *shutters* with which they can turn off their light at will.

Many deep sea fish have in addition to their principal organ of light many minor ones, which give the surrounding waters an iridescent glow. As the fish swim along these many varicolored scintillating lights give off a phosphorescent effect. These flickering will-o'-the-wisps of the deep are chased by openmouthed terrors that follow a searchlight at the tip of their own nose.

The lights with all their many shades of color, patterns, and places of attachment are primarily used for the identification of the species and the sexes. They are of secondary importance in the aid they give for the search of food, in which case they are undoubtedly used to attract, dazzle, and entrap its prey. Oh! yes. They are some little *Vampires* all by themselves.

But in order to see the phosphorescent glimmer of a fish at a distance, the eyes have been peculiarly modified. The greatest possible number of rays of light given off by a point are absorbed by the eye, and this is effected by either enlarging the eye as a whole or by enlarging only the lens and removing the retina to a distance. In this way the eyes have become cylindrical.

It is not the deep sea fish alone that possess organs of light. Some varieties of fish inhabiting the well lighted part of the ocean have them as well. These, which are commonly called "lantern fish," emit, at rhythmic intervals, a greenish-white light. A shutter, which is an opaque membrane similar to that found on a camera, is pushed or pulled over the light organ. This effectually conceals the rays. Two small varieties comprising the Anomalopidae inhabit the Malay archipelago at the Sunda islands, while a third variety has recently been discovered near Jamaica.

Our front cover shows three very interesting species of deep sea fish. The fish illustrated at the top is *Gigantura chuni, A Br.* The fish in the center with the peculiar elongated nose-piece is *Gigantactis vanhoeffeni, A. Br.* While the bottom fish is *Stylophthalmus pardoxus, A. Br.*

These are not very large fish, as one might think, and the illustrations on our front cover are about half size. In other words, the fish are only about twice as large as shown on our cover. The fish illustrated at the top is also slightly luminous around its body, as can be seen. One of the most curious of these fish without doubt is the middle fish. Why Nature should have equipt it with such a long nose-piece, the end of which is luminous, is not well understood as yet, as we know very little about these fish. The interesting part about the lower fish is that it has luminous organs all along its sides, while the eyes themselves are but slightly luminous. It is curious that the eyes themselves are not in sockets as is usually found the case with nearly all other animals, but that they extend several inches from the head.

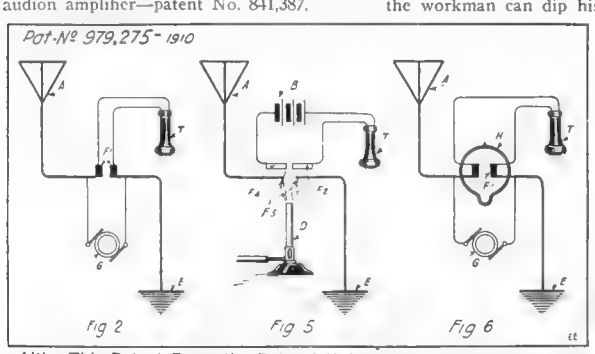
[*Editor's Note: The curious deep sea fish shown on our front cover were prepared from color drawings made by Dr. Bade himself. He in turn worked from the actual fish brought from the deep when making his drawings.*]

HOW I INVENTED THE AUDION.

(*Continued from page 820*)

that before long the wireless telephone will be installed on thousands of vessels, supplementing, and in many cases, supplanting the wireless telegraph. In addition there is an enormous number of small vessels where a wireless telephone installation is more feasible.

As indicative of the growth of the Audion Art, the number of patents issued on various devices and circuits dependent thereon, gives a pretty fair key: Up to 1912 there had been issued about 20 patents, all filed subsequent to 1904. To-day there are over 100 United States patents on the Audion Art, and the number is very rapidly growing. Regardless of what name may be applied to the device patented, practically everyone of these patents since 1906 shows the three electrode bulb. They may all therefore be properly described as the outgrowth of the ideas first shown in the audion amplifier—patent No. 841,387.



Altho This Patent Bears the Date of 1910, It Was Originally Filed in 1904, and Is One of the Basic Patents in All Audion Development. It Shows the First Use of Incandescent Filaments in an Enclosed Chamber, and, Moreover, It Includes at Fig. 5 the First Evidence of the Third Electrode or "Grid" Conception. Here, as Will Be Evident, Is the First Plan for Separating the Antenna Circuit from the Local Circuit.

EXPERIMENTAL CHEMISTRY.

(*Continued from page 794*)

cuprous oxid, or gold; *Yellowish-green,* by uranium oxid; *Green,* by chromic or cupric oxids; *Milk or Opal* glass is made by the addition of bone-ash, tin or zinc oxids. The green color of the common window glass or bottle glass is caused by the presence of ferrous oxid in the sand; this discoloration may be removed by addition of manganese dioxid in the make-up. This serves to oxidize the ferrous to ferric oxid, which imparts a yellow tint, being neutralized by the violet produced by the manganese as a complimentary color.

Pure white sand is mixed with the metallic oxids required, in the proportion which experience has shown gives the best results, and some old glass, called "cullet", is added to improve the quality. The mixture is then put into pots as shown in Fig. 159. These pots are made of the most refractory fire-clay, and are placed in a circular furnace with openings thru which the workman can dip his long iron blowpipe into the pots. Fig. 160 shows such a furnace in cross-section.

The fuel now used is mostly gaseous, and an intense heat is maintained for hours, till the substances are completely fused and mixed. The glassworker dips his blowpipe—a hollow iron rod 5 or 6 feet long, into the fused mass, removes a small portion, rolls it on a smooth iron

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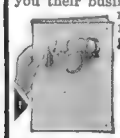

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surface, swings it around in the air, blowing meanwhile thru the rod, cuts it with shears, curves and bends it at will, welds it, and thus fashions it as desired into flasks, lamp shades, etc. For such uses as bottles the glass is run into molds. For other purposes, such as lamp bulbs, chemical flasks and apparatus it is blown. For still other kinds it is rolled, as window glass. In order that glass objects will not break easily, they must undergo a process of *annealing,* that is slowly *cooled,* so that the molecules may arrange themselves in a natural way.

Pottery and Porcelain.

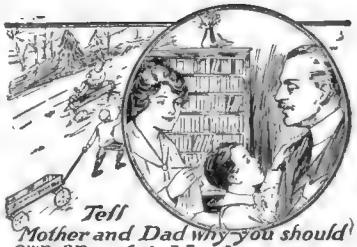
Genuine porcelain and chinaware are manufactured from a fine white clay, *Kaolin,*—resulting from the disintegration of feldspathic rocks,—and silica. After being fashioned the porcelain is "fired," then glazed and refired. One mode of glazing consists in dipping the object into a powder of feldspar and silica suspended in vinegar, and then fusing. Jugs, drain pans, and coarse earthenware are glazed by volatilizing sodium chlorid in an oven, which holds the porous material. The glaze goes into the pores of the ware, with which it partially combines to form sodium and aluminum silicates. If on being heated the ware and glaze expand uniformly the glaze will not crack. Flower pots and other porous pottery illustrate clay that has been moulded and baked, *but not glazed.* Bricks are baked clay.

THE ROGERS UNDERGROUND WIRELESS.

(*Continued from page 789*)

mained enthusiastic and sincere in all the tests and installations made of my under-ground radio system thru all the trials and disappointments of its development, even when the system seemed to prove unworkable. Their perseverance and high skill in the radio art has hastened the official endorsement and the installation of the buried and submerged antenna." Commander A. Hoyt Taylor, D.Sc., U. S. N.; Dr. L. W. Austin, of the Bureau of Standards; Admiral Strother Smith, U. S. N.; Commander Hooper, U. S. N.; G. H. Clark, Expert Radio Aid, U. S. N.; Dr. George W. Pierce, of Harvard University; and Ensign A. Crossley, U. S. N., who has been actively engaged on the installation of the Rogers system at the Great Lakes Naval Radio Station, besides New Orleans, New London, Conn. (test station, now abandoned), and Norfolk, Va.

Like many other great inventions the exact mode of operation is hard to ascertain and define. The views of Mr. Rogers on the operation of this wireless system are briefly defined as follows:—First, that the electric energy liberated at the base of an antenna will be propagated thru the earth even in the absence of etheric space waves above, if such a condition were possible, and which in reality does occur when great distances are signalled over, so he believes. Second, that the propagation of earth waves no more depend upon the ether waves above the surface of the earth than these etheric space waves depend upon the earth waves. Further, that both waves are propagated simultaneously, one above and the other below the surface of the earth, and that at the initial start each is dependent upon the other, altho thereafter neither is dependent upon the other. Furthermore, Mr. Rogers believes that the ether waves gradually die out in intensity in proportion to the earth's curvature, and the distance over which they are propagated, and that at great distances the ether space waves do not have any appreciable effect upon receiving appliances, and that these are energized solely by the energy transmitted thru the earth.



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These ground currents travel with the speed of light and are picked up at the receiving station. The space waves persist for an appreciable distance, which accounts for air-plane to air-plane and air-plane-to-earth radio-communciation, but it is the belief of Mr. Rogers that in such long distance radio transmission as half-way around the globe (12,000 miles) that it is the ground wave current that does the work, and that the free space wave above the surface of the earth never reaches the station, due to the high resistance of the atmospheric envelope.

One of the Naval experts present mentioned that it has been found, that the penetration of the ground wave component increases with an increase in wave length. This is an important fact and helps to explain the operation of this new radio system, with its aërials buried in the ground. He also mentioned that "Radio to Mars" or other planets would be impossible, if we are to believe in the well-known "Heaviside" ionization layer, surrounding the earth at a height computed at from 30 to 50 miles, for no etheric wave can pass this layer without being reflected back to the earth, or at least restrained within this passageway.

Rogers System Eliminates "Static" and "Interference".

Mr. Rogers stated that his underground antenna, in itself, did not solve entirely the static or interference problem, but it made the nearest approach to this ideal condition —the goal of all radio engineers—than had ever been accomplisht before. This problem has, thanks to a new arrangement perfected by Commander A. Hoyt Taylor, D.Sc., been solved and *static and interference have been practically totally eliminated, for all-year-around radio service.* Think what an advance this means! Further, *there is no rise and fall in the signal strength during the night or day, at any time of the year, due to the sun's ionization effect, as is the case where elevated antennae are employed.* The U. S. Naval reports and tests made with the Rogers' ground aërial in comparison with the usual form of elevated aërial, several of which are appended herewith, show the incomparable efficiency of this new radio system.

What the Facts Show.

First we will mention the test which Mr. Rogers and a naval officer conducted for the writer. The apparatus used in these tests are shown in the accompanying photographs. They included several large tuning inductances, variable condensers, a one-step audion amplifier (single Audiotron bulb only!) and two pairs of Baldwin 'phones (telephone receivers). This apparatus was connected up to one of Mr. Rogers' latest buried antennas—a single rubber covered, stranded copper cable, about the size of a small ignition cable, extending westward for a distance of 4,000 feet, so as to be in a plane with the high power European radio stations. *This cable is encased in iron pipe (gas pipe)*, each 20 foot section of which is insulated from the abutting sections by means of a rubber hose (garden hose) slipt over the pipe ends for a few inches. This is buried in a dirt trench about 3 feet deep, filled in with soil. The cable is insulated at the free end and is connected up as in Fig. 2. The rubber covered wire alone has been used in all sub-aqueous tests, and gives fine results when simply buried in the ground, the decay not being so rapid as probably would be imagined. This latest aërial in the iron pipe is a new development and experiments are still going on with it. It works wonderfully well. The 4,000 foot aërial here described is best suited to receiving wave lengths of 6,000 to 16,000 meters. For shorter wave lengths aërials of smaller dimensions are employed.

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"Here's the 'Lyons' station in France," said Mr. Rogers. A turn of the knob on the specially calibrated condenser, and there was "Lyons" (France)—sure enough. *Static and interference were unheard.* Next the great stations across the broad Atlantic, at Nauen, Germany; Carnarvon, Wales (England); and Rome, Italy, were heard with equal loudness and clarity. This laboratory station, which has been used by the Navy Department during the war, has picked up practically all the high power stations on the globe. American stations were then picked up by changing the wave length, and finally a test was made on a short (250 feet in length) buried ground antenna, adapted to receiving wave lengths of 200 to 800 meters. Wireless telephone messages were picked up from Washington, a distance of about seven miles. It is most interesting to note at this juncture, as the Naval tests at Norfolk, Va., on a similar aërial have shown, that a radio message from an airplane cannot be picked up on the underground aërial, until the 'plane is directly over the station. This would seem to prove two things—first, that the short waves sent out by the airplane radio set do not penetrate into the ground very far, if at all,—and second, that airplane radio transmission and reception are effected solely by etheric waves.

Referring to Figures 3 and 4, we find several interesting points. Fig. 3-A, shows how a double ground aërial is sometimes connected. Also, as in the case of Mr. Rogers' test station, several sets of these buried antennae are best employed, distributed about the station as shown in Fig. 3-B.

The Rogers underground antenna system has been used at the Belmar, N. J., station during the war with most gratifying results, as reported by the Navy Department, and its successful and unfailing operation during the twenty-four hours of the day, resulted in trebling and quadrupling the capacity of this great trans-Atlantic highway of intelligence communication. The official reports in connection with the work accomplished with the underground Rogers system at Belmar state that not a single word of communication was lost during the reception of thousands of important official messages from Europe. The station at Tuckerton, N. J., has also been equipt with the Rogers underground aërial system and all of the larger stations of the Allied Powers in Europe have been copied successfully thru the 24 hours, at this point also.

Submarine Wireless.

Perhaps the most interesting tests of all are those which were made on *submerged* submarines *in salt water!* The aerial in this case was of heavily insulated stranded cable, stretched from stem to stern as Fig. 4-A illustrates. The two aërials were brought down thru the conning tower and joined to the receiving apparatus. A second form of aërial is illustrated at Fig. 4-B, where the insulated aërial wires are placed in iron pipes within the submarine. Here are the results of some of these tests, which do not include the transmitting tests to the submarine, from a ground antenna on shore. When submerged 8 feet, the German station at Nauen was picked up by the submarine while lying off the American coast! *Submarines have, in other official tests, picked up distant stations when submerged 21 feet, on a wave length of* 12,600 *meters or greater wave lengths.*

One of the naval officers, who has had much to do with the testing of the Rogers' system, stated that experience had demonstrated that *in fresh water the submerged antenna may be placed at any depth.* Salt water acts differently, but the aërial may be submerged any desired depth for wave lengths above 10,000 meters.

The same officer, who has made a close study of all American and European work in radio, explained how the best work ever done in radio was accomplisht at the Great Lakes Naval Station, on the shore of Lake Michigan. Fig. 5 gives the general arrangement of this station. The test station was on the beach and acted as a "remote control" station for the standard station at A. The shortest distance between a "receiving and control station" in the naval radio service heretofore has been 36 *miles.* Here a distance of 600 feet only, separate the elevated aërial of the main station from the submerged Rogers antenna terminating at the test station, B. Said he, "Now let the inventors of 'static and interference' preventers trot out their little pets, and show what they can DO! Here's what this station *actually did on schedule service: With* 48 *amperes, at* 4,000 *meters wave length, being radiated in the elevated main antenna—the beach station,* ONLY 600 FEET AWAY, *was picking up Nauen on* 12,600 *meters, and New Orleans on* 5,000 *meters, without any interference or static —all on the Rogers sub-aqueous aërials.* These were rubber-covered cables spreading in different directions, any one of which could be used, and laying 50 feet deep in the water at their outer extremities.

Imagine such a wonderful performance! But this is not all. The official tests show that the station at Cavite, P. I., 8,100 miles away, was received regularly on the Rogers sub-aqueous aërials at the Lake Michigan Station, *on schedule service,* at 11 A. M. and 5:30 P. M. daily, the working periods of that station.

Transmitting On Underground Aerials.

Tests were made by the naval experts, as well as by Mr. Rogers in his very first experiments in transmission from a ground or under-water antenna. *These were all successful.* It is only a matter of properly insulating the antenna so that it will not break down under the high potential applied to it by the transmitter. The early tests by the inventor were made with a one inch spark coil to the Bureau of Standards Radio Laboratory, a distance of seven miles, *the received signals having an audibilty of* 2,000, *i.e.,* 2,000 *times the strength of a clear, readable signal.* The audibility of the signals at the Washington Navy Yard

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(See review of this book by Editor in December issue of your Electrical Experimenter page 568)

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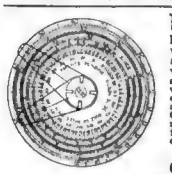

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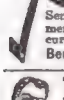

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was 1,000. The transmitting tests at the Great Lakes Naval Station were made at first with a low power Oscillion bulb transmitter and later with a Clapp-Eastham hytone set. An elevated amateur style antenna of two wires was strung up between two houses 38 miles away. Clear signals were received with an audibility strength of 2,000. The ignition cable used for the aërial finally punctured, but *even then* the signals received were four times louder than the best amateur transmitter could send on a regular aërial, as tests proved.

Official U. S. Naval Tests of Underground Reception, at Naval Station, New Orleans, La., During 1917.

Excerpts.

In general, (relating to the Rogers' system) the point of interest lies in the use of wires buried in the ground, for both the transmitting and the receiving antenna. For instance, in receiving, a wire buried one foot below the surface of the earth extends for several hundred feet south of the receiving station, and a similar wire north, the receiver being located between the pairs of wires. The ordinary receiver was used. With this arrangement, signals from Darien, Nauen, and all Atlantic stations were received.

Tests at New Orleans Station.

Federal receiver used on main antenna, Western Electric receiver used on underground antenna, 1,400 feet buried wire. (The figures refer to audibility.)

	Main Antenna		Underground Antenna		
Station	Wave Length	Sig. aud.	Static aud.	Sig. aud.	Static aud.
San Diego	9800	1200	1000	750	15
Arlington	7500	2000	3000	1500	50

Impossible to read Arlington on the elevated antenna on account of static interference. United Fruit Company station of New Orleans interfered with signals from Arlington on main antenna, *but offered no interference* on underground antenna.

Test on message from U. S. S. "Are-

(*Continued on page* 839)

ALEXANDER WIRELESS BILL IS KILLED.

(*Continued from page* 786)

today we are not at all excited even about the amendment of the Alexander Bill for we have good and sufficient reasons to believe that the Alexander Bill amended has little chance to become a law."

That our judgment was correct is borne out by the fact that the bill was actually killed a month later. Many interesting things came to light during the hearings before Mr. Alexander in the latter part of December. A number of well-meaning amateurs, small and large, professional and otherwise, had flocked to Washington to give testimony and to protest against the Alexander Bill. However, before they arrived in Washington, a flood of protesting letters from amateurs had descended upon the national capital, and it was found that their services were not at all needed, for before their arrival several amendments had already been gotten up and were in print.

It is not our intention to belittle the genuine efforts made by these amateurs who went to Washington in person to fight for the cause, but we do not think that in the testimony given as publisht in the printed records, anything new was shown or any evidence given that was not already known by the Committee. It brought out, however, the interesting fact over and over that the 1912 bill was elastic enough to cover any emergency as far as the radio

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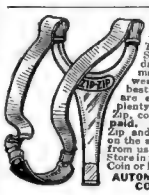

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amateur is concerned, and this is a good thing. We had maintained right along and we stated so in our January and February issues, that no amendment nor new law was at all required. We had no suggestions to make, the old law was good enough, and we said so,—if any change at all was to be made, we were for the Padgett bill, which left the amateur just exactly where he was before the new bill came up. Naturally we are glad to see that our judgment proved right, for official Washington thought so, too. The old law is good enough, it covers every possible phase of the amateur, and we do not think that any legislator could do better than the Radio Act of 1912.

An interesting side light of the disturbed state of mind of the visiting Washington radio amateurs appeared to be their unanimous holy fear of the United States Navy. They all seemed to be obsest, any, panic-struck that the Navy Department was out to kill the amateurs, which as a matter of fact, the Navy, speaking generally, was not.

We believe that our opinion is shared by those who know the inside facts, that the Alexander Bill as originally framed was a hasty measure, because at the time it probably was thought that Government ownership for radio was ripe, and that such a measure could be rushed thru in haste. The sponsors of the bill, however, made two fundamental mistakes: First, the country was and is not ripe for public ownership as yet. Second, it was found that several hundred thousand red-blooded American citizens, better known as Radio Amateurs, cannot be wiped off the earth by means of a blue pencil. Such methods might have had a small chance before the war, but after what we have gone thru in democratizing the world and freedom for everybody, there never was a ghost of a chance of the measure succeeding. Several senators and congressmen voiced their opinion on this point in no uncertain tones, and we are certain that if the bill should come up again during the next few years, which by the way we doubt, it will experience exactly the same fate.

Another mistake, which, however, is made by a great many people outside of Washington is that for some curious reason the amateurs at large has always been looked upon as a boy in his knickers. Even well informed Washington was greatly surprised to receive letters from "young" amateurs 60 and 70 years old, and these "boys" were just as vehement in their protests as the young man of 20. Then the amateurs in uniform were legion, and their parents voiced their sons' sentiments, being that the sons themselves were perhaps in France or elsewhere. Further, the great horde of amateurs known as jewelers made themselves heard lustily.

There are today thousands of jewelers located all over this broad land, whose business it is to serve their community by giving them the right time. They also require daily time signals in their business. This time service was given free to them by Uncle Sam every day by the time signals sent out by Arlington and other powerful Government stations. These amateurs under the original Alexander bill would have been killed just the same as their brethren who pursue wireless more or less for instructional purposes, and you may be sure that these jewelers were loud in their complaints.

Our amateurs are to be congratulated in their solitary fight which they put up for their rights, and we congratulate them upon their thoro victory.

There is, however, one serious point which we desire to broach, and that is the following:

When we first heard that a new wireless measure was to be rushed thru Congress,—which if it had actually past, would have killed American radio amateurism,—we took it up ourselves to broach the important news to every amateur on record.

The RADIO LEAGUE OF AMERICA, which was organized three years ago was formed for just such a purpose, viz., to keep the amateurs together and to ward off unfair legislation. Unfortunately, only about 20,000 amateurs had been registered with the League, altho it does not cost one cent to join the League. So when we came to write the letters to all the amateurs we only had 20,000 names of the League, while the other names were made up from various lists which we had in our office, and which lists were not at all reliable on account of removals of amateurs, etc.

We wish to take this occasion to urge every amateur to fill out the blank printed at the end of this article and join the League at once. *It does not cost a cent to do so,* except three-cent postage with which to mail this blank. You immediately become a member, and any important news can then be transmitted to you immediately without delay. It should be apparent to every amateur that being a member of the *Radio League of America* can only benefit him, and inasmuch as there are no dues or fees to be paid, there is absolutely no good reason why every amateur should not be in it.

Peace will soon be declared by the President and then everybody will be allowed again to operate his or their stations, and being a member in this well-established League of national scope and reputation can only benefit the owner of the radio station. Then, too, every amateur owes it to his Government that in time of peril his services can be drawn upon and his station used, and only by having a central body which has all such information can radio amateurism in the United States grow to its fullest and greatest importance.

Application for Membership in the Radio League of America

I, THE UNDERSIGNED, a Radio Amateur, am the owner of a Wireless Station. My station has been in use since..... and I herewith desire to apply for membership in the RADIO LEAGUE OF AMERICA. I understand that the Radio League of America is a National Scientific Organization for the pursuit of the Radio Arts. I will not be called upon to pay membership fees, or dues, and once enrolled I am to share in all the privileges of a regular member.

Upon receipt of this form properly filled out you are to send me your eight-page booklet describing the purpose of the League, rules, etc.

Name.....

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State.....

Date.....191

Mail this blank to Radio League of America, 231 Fulton St., New York City.

3-19

Editor, ELECTRICAL EXPERIMENTER,
233 Fulton Street,
New York, N. Y.

SIR:

It has been noted by this office that on page 707 of the February issue of the "Electrical Experimenter" you printed certain proposed amendments to a bill for Government Ownership of Radio Communication. On page 735 in an article entitled "Radio Amateurs Discussed Officially" you stated that this amendment was drafted by Lieutenant J. C. Cooper, Jr., U. S. N. R. F. You have evidently been misinformed. The amendment printed by you was not drafted by the Navy Department and was not discussed before the House Committee at the hearings.

The amendment actually drafted by Lieutenant Cooper and discussed before the Committee appears in the testimony of Captain Todd on page 39 of the Official Report of the Hearings before the House Committee on Merchant Marine and Fisheries on H. R. 13159, and is as follows:

"Insert after line 6, page 2, the following:

" 'The term "amateur station" means a station used for private practice or experiment in radio communication and not operated for profit in either receiving or sending radio signals.'

"Insert in line 14, page 2, after 'training-school stations' the following: 'and amateur stations.'

"Strike out the sentence beginning in line 1, page 3, and ending in line 6, page 3, and in lieu thereof insert the following:

" 'This section shall not apply to stations belonging to the Government of the United States or the Government of the Philippine Islands, or to experiment stations, technical and training-school stations, and amateur stations, licensed as provided by the act to regulate radio communication, approved August thirteenth, nineteen hundred and twelve: *Provided*, That when such amateur stations are licensed for receiving purposes only no operator's license shall be required for the operator in charge of or operating such station; but when such amateur station is licensed for transmitting also the license shall require that the operator of such station shall hold a license showing his ability to send and receive at least twenty-five words per minute in the Continental Morse code: *And further provided*, That the license for such transmitting station may limit the power input to one-half kilowatt in case of amateur stations within one hundred miles of the Atlantic or Pacific Ocean, the Gulf of Mexico, or the Great Lakes, and to one-quarter kilowatt within five miles of a Government receiving station. Amateur stations so licensed shall not use any wave length exceeding two hundred and fifty meters nor less than one hundred and fifty meters except by special authority in the license contained.' "

In order that the information given your readers may be correct, it is requested that you publish this letter in your March issue of the "Electrical Experimenter."

For your further information, there is being forwarded to you under separate cover a full printed copy of the Hearings before the Committee.

Very respectfully,
(Signed) E. B. WOODWORTH,
Commander, U. S. Navy,
Acting Director Naval Communications.

The amendment drafted by Lieutenant Cooper was scheduled to run in our February issue. At the last moment, due to lack of space, it was crowded out. The amendment printed in our February issue was proposed by Mr. Watson as published by us.—Editor.

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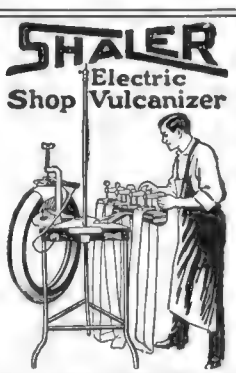

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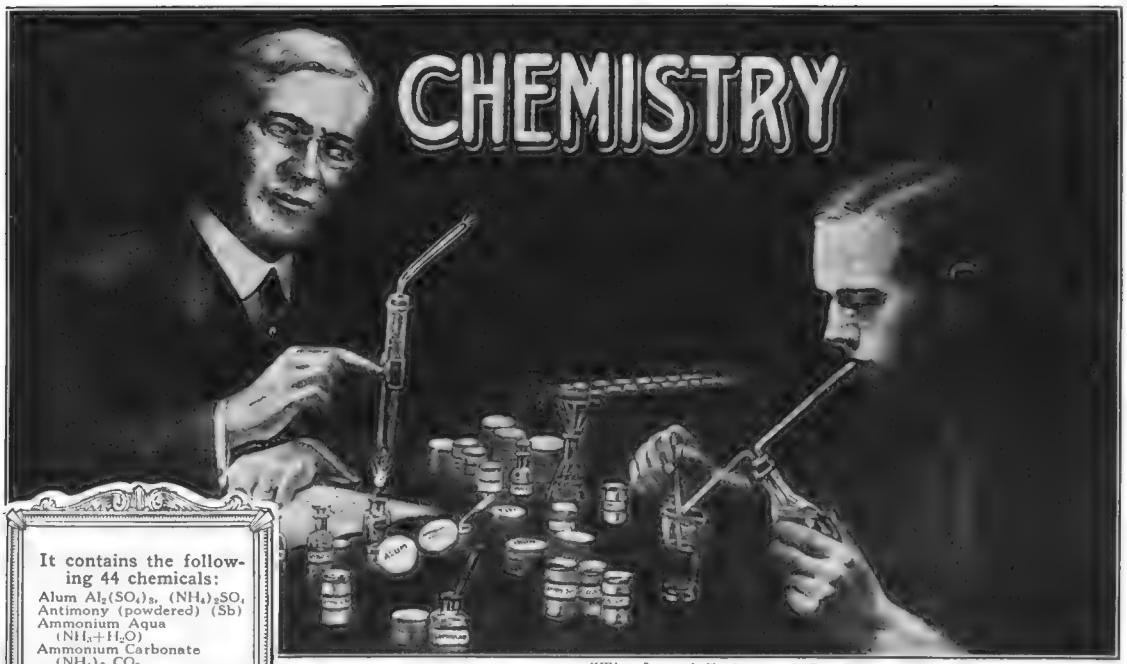

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Calcium Oxide (CaO)
Calcium Sulphate $(CaSO_4 2H_2O)$
Charcoal (Carbon) (C)
Chloride of Zinc $(ZnCl_2)$
Copper Sulphate $(CuSO_4)$
Ferrous Sulphate $(FeSO_4)$
Ferrous Sulphide (FeS)
Glycerol (Glycerine) $C_3H_5(OH)_3$
Hydrochloric Acid (HCl)
Iodine (I)
Iron Chloride $(FeCl_3)$
Iron Oxide (Fe_2O_3)
Lead Acetate Pb $(C_2H_3O_2)_2$
Litmus Paper
Magnesium Carbonate $(MgCO_3)$
Manganese Dioxide (MnO_2)
Mercury (Quicksilver) (Hg)
Nickel Chloride $(NiCl_2)$
Oxalic Acid $(H_2C_2O_4)$
Sodium Bicarbonate $(NaHCO_3)$
Sodium Borate $(NaBO_2)$
Sodium Carbonate (Na_2CO_3)
Sodium Chloride (NaCl)
Sodium Nitrate $(NaNO_3)$
Sodium Phosphate (Na_2HPO_4)
Sodium Sulphate (Na_2SO_4)
Sodium Sulphite (Na_2SO_3)
Stannous Chloride $(SnCl_2)$
Sulphate of Nickel $(NiSO_4)$
Sulphate of Zinc $(ZnSO_4)$
Sulphuric Acid (H_2SO_4)
Tin (Granulated) (Sn)
Zinc (Metal) (Zn)
Zinc Carbonate $(ZnCO_3)$

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THE ROGERS UNDERGROUND WIRELESS.

(*Continued from page* 835)

thusa" at sea about 150 miles from New Orleans.

Main Antenna		Underground Antenna (500' composite)	
Sig	Static	Sig.	Static
400	5000	300	15

The "Arethusa" had been trying to get thru a naval despatch which could not be copied on elevated antenna on account of serious static interference. The despatch was taken on the underground antenna, and *every word copied correctly.*

At 9 P. M., April 7, 1917, it was possible to copy signals from Tuckerton with ease, while static on the elevated antenna made it impossible to read any arc signals.

The following results were obtained with spark signals:

Three hundred foot wires in parallel, ten feet apart, a .002 m.f. condenser in series with primary coil of a Telefunken receiver to obtain 600 meters.

Date	Station	W. L.	Sig. Aud Ground Antenna	Static Aud Ground Antenna	Sig Aud Main Antenna	Static Aud Main Antenna
Apr. 2	Point Isabel	600	15			
Apr. 2	Tampa	600	200	0		3000
Apr. 2	Port Arthur	600	150	0		3000
Apr. 2	Pensacola	1200	20	0	100	150
Apr. 2	Ft. Sam Houston		150			

Of particular interest is the fact that when static *prevents* reception on the main antenna, reception can be continued on the underground antenna. *This has even been done during a severe lightning storm, when the main antenna would have been dangerous without grounding.* Reception is also directional and permits of avoiding interference to some extent by using wire "off direction" of an interfering station.

Strays: Strays are as a rule practically absent. Occasional loud cracks widely separated are received. (Ed. note. This has since been overcome.) These isolated strays, altho frequently loud, do not interfere in the least with the reception of signals. On two occasions, strays have risen to an audibility in excess of 5,000 on these separate cracks, but even in this case, reception of signals, altho a little difficult, *was not interrupted.* On these two occasions it was necessary to *ground* both of the (elevated) aërials at the main station.

Considering the matter of strays, it can be said that on four or five occasions during one week, which was one marked by tremendous storms in the Great Lakes region, that strays rose to an audibility in excess of 10,000 at the beach station. Even in this case, however, signals from boats within 100 miles and from shore stations, such as Ludington, Milwaukee and Manitowoc, were usually readable, because the strays while very loud, were nowhere near as numerous as on the elevated aërial. Durthese periods a messenger was kept at the beach station to carry up messages to the main station, which could not receive these signals on account of the strays.

There seems to be no appreciable advantage in using more than one wire—No. 12 weather proof insulated.

The experiments at Great Lakes confirm the work of the Bureau of Standards on the importance of adequate insulation of the wire. If the wires are grounded at the ends, it does not necessarily make much difference unless they are adjusted to the optimum wire length; but if properly adjusted to this length, grounding of the wires, either intentionally or accidentally, produces a diminuation of the signals, which, however, even with the intentional grounding of the two ends, still leaves them 50% of their maximum value. Therefore, while the question of insulation is important, it does not mean that the system will fail entirely if the insulation becomes faulty.

MY INVENTIONS.

(*Continued from page* 776)

cover. Suddenly my legs went up in the air. In the same instant there was a flash in my brain, the nerves responded, the muscles contracted, I swung thru 180 degrees and landed on my hands. I resumed my walk as tho nothing had happened when the stranger caught up with me. "How old are you?" he asked, surveying me critically. "Oh, about fifty-nine," I replied. "What of it?" "Well," said he, "I have seen a cat do this but never a man." About a month since I wanted to order new eyeglasses and went to an oculist who put me thru the usual tests. He lookt at me incredulously as I read off with ease the smallest print at considerable distance. But when I told him that I was past sixty he gasped in astonishment. Friends of mine often remark that my suits fit me like gloves but they do not know that all my clothing is made to measurements which were taken nearly 35 years ago and never changed. During this same period my weight has not varied one pound.

In this connection I may tell a funny story. One evening, in the winter of 1885, Mr. Edison, Edward H. Johnson, the President of the Edison Illuminating Company, Mr. Batchellor, Manager of the works, and myself entered a little place opposite 65 Fifth Avenue where the offices of the company were located. Someone suggested guessing weights and I was induced to step on a scale. Edison felt me all over and said: "Tesla weighs 152 lbs. to an ounce," and he guest it exactly. Stript I weighed 142 lbs. and that is still my weight. I whispered to Mr. Johnson: "How is it possible that Edison could guess my weight so closely?" "Well," he said, lowering his voice, "I will tell you, confidentially, but you must not say anything. He was employed for a long time in a Chicago slaughter-house where he weighed thousands of hogs every day! That's why." My friend, the Hon. Chauncey M. Depew, tells of an Englishman on whom he sprung one of his original anecdotes and who listened with a puzzled expression but—a year later—laughed out loud. I will frankly confess it took me longer than that to appreciate Johnson's joke.

Now, my well being is simply the result of a careful and measured mode of living and perhaps the most astonishing thing is that three times in my youth I was rendered by illness a hopeless physical wreck and given up by physicians. More than this, thru ignorance and lightheartedness, I got into all sorts of difficulties, dangers and scrapes from which I extricated myself as by enchantment. I was almost drowned a dozen times; was nearly boiled alive and just mist being cremated. I was entombed, lost and frozen. I had hair-breadth escapes from mad dogs, hogs, and other wild animals. I past thru dreadful diseases and met with all kinds of odd mishaps and that I am hale and hearty today seems like a miracle. But as I recall these incidents to my mind I feel convinced that my preservation was not altogether accidental.

An inventor's endeavor is essentially life-saving. Whether he harnesses forces, improves devices, or provides new comforts and conveniences, he is adding to the safety of our existence. He is also better qualified than the average individual to protect himself in peril, for he is observant and resourceful. If I had no other evidence that I was, in a measure, possest of such qualities I would find it in these personal experiences. The reader will be able to judge for himself if I mention one or two instances. On one occasion, when about 14 years old, I wanted to scare some friends who were bathing with me. My plan was to dive under a long floating structure and slip out quietly at the other end. Swimming and diving came to me as naturally as to a

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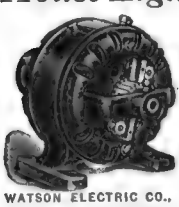

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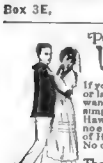

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duck and I was confident that I could perform the feat. Accordingly I plunged into the water and, when out of view, turned around and proceeded rapidly towards the opposite side. Thinking that I was safely beyond the structure, I rose to the surface but to my dismay struck a beam. Of course, I quickly dived and forged ahead with rapid strokes until my breath was beginning to give out. Rising for the second time, my head came again in contact with a beam. Now I was becoming desperate. However, summoning all my energy, I made a third frantic attempt but the result was the same. The torture of suppress breathing was getting unendurable, my brain was reeling and I felt myself sinking. At that moment, when my situation seemed absolutely hopeless, I experienced one of those flashes of light and the structure above me appeared before my vision. I either discerned or guest that there was a little space between the surface of the water and the boards resting on the beams and, with consciousness nearly gone, I floated up, prest my mouth close to the planks and managed to inhale a little air, unfortunately mingled with a spray of water which nearly choked me. Several times I repeated this procedure as in a dream until my heart, which was racing at a terrible rate, quieted down and I gained composure. After that I made a number of unsuccessful dives, having completely lost the sense of direction, but finally succeeded in getting out of the trap when my friends had already given me up and were fishing for my body.

That bathing season was spoiled for me thru recklessness but I soon forgot the lesson and only two years later I fell into a worse predicament. There was a large flour mill with a dam across the river near the city where I was studying at that time. As a rule the height of the water was only two or three inches above the dam and to swim out to it was a sport not very dangerous in which I often indulged. One day I went alone to the river to enjoy myself as usual. When I was a short distance from the masonry, however, I was horrified to observe that the water had risen and was carrying me along swiftly. I tried to get away but it was too late. Luckily, tho, I saved myself from being swept over by taking hold of the wall with both hands. The pressure against my chest was great and I was barely able to keep my head above the surface. Not a soul was in sight and my voice was lost in the roar of the fall. Slowly and gradually I became exhausted and unable to withstand the strain longer. Just as I was about to let go, to be dashed against the rocks below, I saw in a flash of light a familiar diagram illustrating the hydraulic principle that the pressure of a fluid in motion is proportionate to the area exposed, and automatically I turned on my left side. As if by magic the pressure was reduced and I found it comparatively easy in that position to resist the force of the stream. But the danger still confronted me. I knew that sooner or later I would be carried down, as it was not possible for any help to reach me in time, even if I attracted attention. I am ambidextrous now but then I was left-handed and had comparatively little strength in my right arm. For this reason I did not dare to turn on the other side to rest and nothing remained but to slowly push my body along the dam. I had to get away from the mill towards which my face was turned as the current there was much swifter and deeper. It was a long and painful ordeal and I came near to failing at its very end for I was confronted with a depression in the masonry. I managed to get over with the last ounce of my force and fell in a swoon when I reached the bank, where I was found. I had torn virtually all the skin from my left side and it took several weeks before the fever subsided and I was well. These are only two

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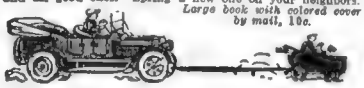

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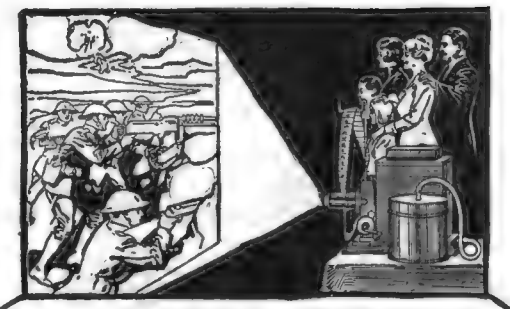
of many instances but they may be sufficient to show that had it not been for the inventor's instinct I would not have lived to tell this tale.

Interested people have often asked me how and when I began to invent. This I can only answer from my present recollection in the light of which the first attempt I recall was rather ambitious for it involved the invention of an *apparatus* and a *method*. In the former I was anticipated but the latter was original. It happened in this way. One of my playmates had come into the possession of a hook and fishing-tackle which created quite an excitement in the village, and the next morning all started out to catch frogs. I was left alone and deserted owing to a quarrel with this boy. I had never seen a real hook and pictured it as something wonderful, endowed with peculiar qualities, and was despairing not to be one of the party. Urged by necessity, I somehow got hold of a piece of soft iron wire, hammered the end to a sharp point between two stones, bent it into shape, and fastened it to a strong string. I then cut a rod, gathered some bait, and went down to the brook where there were frogs in abundance. But I could not catch any and was almost discouraged when it occurred to me to dangle the empty hook in front of a frog sitting on a stump. At first he collapsed but by and by his eyes bulged out and became bloodshot, he swelled to twice his normal size and made a vicious snap at the hook. Immediately I pulled him up. I tried the same thing again and again and the method proved infallible. When my comrades, who in spite of their fine outfit had caught nothing, came to me they were green with envy. For a long time I kept my secret and enjoyed the monopoly but finally yielded to the spirit of Christmas. Every boy could then do the same and the following summer brought disaster to the frogs.

In my next attempt I seem to have acted under the first instinctive impulse which later dominated me—to harness the energies of nature to the service of man. I did this thru the medium of May-bugs—or June-bugs as they are called in America—which were a veritable pest in that country and sometimes broke the branches of trees by the sheer weight of their bodies. The bushes were black with them. I would attach as many as four of them to a cross-piece, rotably arranged on a thin spindle, and transmit the motion of the same to a large disc and so derive considerable "power." These creatures were remarkably efficient, for once they were started they had no sense to stop and continued whirling for hours and hours and the hotter it was the harder they worked. All went well until a strange boy came to the place. He was the son of a retired officer in the Austrian Army. That urchin ate May-bugs alive and enjoyed them as tho they were the finest blue-point oysters. That disgusting sight terminated my endeavors in this promising field and I have never since been able to touch a May-bug or any other insect for that matter.

After that, I believe, I undertook to take apart and assemble the clocks of my grandfather. In the former operation I was always successful but often failed in the latter. So it came that he brought my work to a sudden halt in a manner not too delicate and it took thirty years before I tackled another clockwork again. Shortly thereafter I went into the manufacture of a kind of pop-gun which comprised a hollow tube, a piston, and two plugs of hemp. When firing the gun, the piston was prest against the stomach and the tube was pushed back quickly with both hands. The air between the plugs was comprest and raised to high temperature and one of them was expelled with a loud report. The art consisted in selecting a tube of the proper taper from the hollow stalks which were

(*Continued on page* 843)



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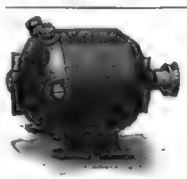

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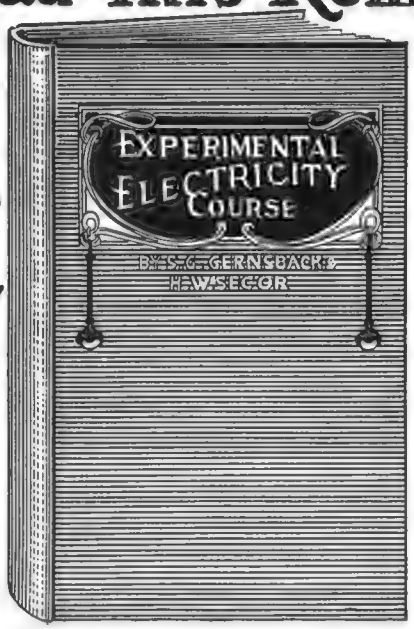

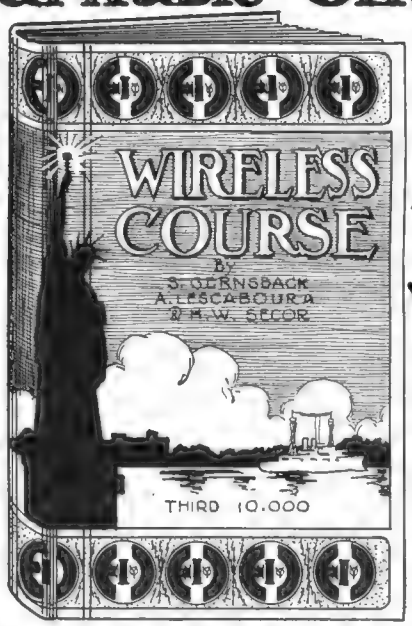

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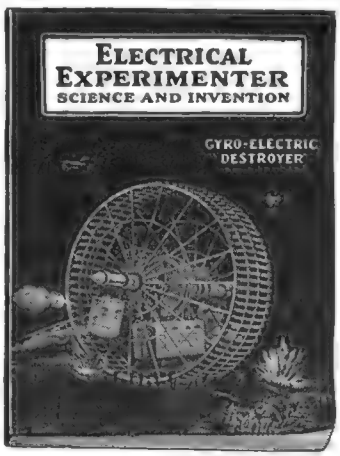

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MY INVENTIONS

(*Continued from page* 841)

did very well with that gun but my activities interfered with the window panes in our house and met with painful discouragement. If I remember rightly, I then took to carving swords from pieces of furniture which I could conveniently obtain. At that time I was under the sway of the Serbian national poetry and full of admiration for the feats of the heroes. I used to spend hours in mowing down my enemies in the form of corn-stalks which ruined the crops and netted me several spankings from my mother. Moreover these were not of the formal kind but the genuine article.

I had all this and more behind me before I was six years old and had past thru one year of elementary school in the village of Smiljan where I was born. At this juncture we moved to the little city of Gospic nearby. This change of residence was like a calamity to me. It almost broke my heart to part from our pigeons, chickens and sheep, and our magnificent flock of geese which used to rise to the clouds in the morning and return from the feeding grounds at sundown in battle formation, so perfect that it would have put a squadron of the best aviators of the present day to shame. In our new house I was but a prisoner, watching the strange people I saw thru the window blinds. My bashfulness was such that I would rather have faced a roaring lion than one of the city dudes who strolled about. But my hardest trial came on Sunday when I had to dress up and attend the service. There I met with an accident, the mere thought of which made my blood curdle like sour milk for years afterwards. It was my second adventure in a church. Not long before I was entombed for a night in an old chapel on an inaccessible mountain which was visited only once a year. It was an awful experience, but this one was worse. There was a wealthy lady in town, a good but pompous woman, who used to come to the church gorgeously painted up and attired with an enormous train and attendants. One Sunday I had just finished ringing the bell in the belfry and rushed downstairs when this grand dame was sweeping out and I jumped on her train. It tore off with a ripping noise which sounded like a salvo of musketry fired by raw recruits. My father was livid with rage. He gave me a gentle slap on the cheek, the only corporal punishment he ever administered to me but I almost feel it now. The embarrassment and confusion that followed are indescribable. I was practically ostracised until something else happened which redeemed me in the estimation of the community.

An enterprising young merchant had organized a fire department. A new fire engine was purchased, uniforms provided and the men drilled for service and parade. The engine was, in reality, a pump to be worked by sixteen men and was beautifully painted red and black. One afternoon the official trial was prepared for and the machine was transported to the river. The entire population turned out to witness the great spectacle. When all the speeches and ceremonies were concluded, the command was given to pump, but not a drop of water came from the nozzle. The professors and experts tried in vain to locate the trouble. The fizzle was complete when I arrived at the scene. My knowledge of the mechanism was nil and I knew next to nothing of air pressure, but instinctively I felt for the suction hose in the water and found that it had collapsed. When I waded in the river and opened it up the water rushed forth and not a few Sunday clothes were spoiled. Archimedes running naked thru the streets of Syracuse and shouting Eureka at the top of his voice did not make a greater impression than myself. I was carried on the shoulders and was the hero of the day.

Upon settling in the city I began a four-years' course in the so-called Normal School preparatory to my studies at the College or *Real-Gymnasium*. During this period my boyish efforts and exploits, as well as troubles, continued. Among other things I attained the unique distinction of champion crow catcher in the country. My method of procedure was extremely simple. I would go in the forest, hide in the bushes, and imitate the call of the bird. Usually I would get several answers and in a short while a crow would flutter down into the shrubbery near me. After that all I needed to do was to throw a piece of cardboard to detract its attention, jump up and grab it before it could extricate itself from the undergrowth. In this way I would capture as many as I desired. But on one occasion something occurred which made me respect them. I had caught a fine pair of birds and was returning home with a friend. When we left the forest, thousands of crows had gathered making a frightful racket. In a few minutes they rose in pursuit and soon enveloped us. The fun lasted until all of a sudden I received a blow on the back of my head which knocked me down. Then they attacked me viciously. I was compelled to release the two birds and was glad to join my friend who had taken refuge in a cave.

In the schoolroom there were a few mechanical models which interested me and turned my attention to water turbines. I constructed many of these and found great pleasure in operating them. How extraordinary was my life an incident may illustrate. My uncle had no use for this kind of pastime and more than once rebuked me. I was fascinated by a description of Niagara Falls I had perused, and pictured in my imagination a big wheel run by the Falls. I told my uncle that I would go to America and carry out this scheme. Thirty years later I saw my ideas carried out at Niagara and marveled at the unfathomable mystery of the mind.

I made all kinds of other contrivances and contraptions but among these the arbalists I produced were the best. My arrows, when shot, disappeared from sight and at close range traversed a plank of pine one inch thick. Thru the continuous tightening of the bows I developed skin on my stomach very much like that of a crocodile and I am often wondering whether it is due to this exercise that I am able even now to digest cobble-stones! Nor can I pass in silence my performances with the sling which would have enabled me to give a stunning exhibit at the Hippodrome. And now I will tell of one of my feats with this antique implement of war which will strain to the utmost the credulity of the reader. I was practicing while walking with my uncle along the river. The sun was setting, the trout were playful and from time to time one would shoot up into the air, its glistening body sharply defined against a projecting rock beyond. Of course any boy might have hit a fish under these propitious conditions but I undertook a much more difficult task and I foretold to my uncle, to the minutest detail, what I intended doing. I was to hurl a stone to meet the fish, press its body against the rock, and cut it in two. It was no sooner said than done. My uncle looked at me almost scared out of his wits and exclaimed *"Vade retro Satanas!"* and it was a few days before he spoke to me again. Other records, however great, will be eclipsed but I feel that I could peacefully rest on my laurels for a thousand years.

(In the April issue Mr. Tesla will describe in detail how he conceived one of his most important and far reaching inventions: "The Rotary Magnetic Field."—Editor.)

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Continued on page 846

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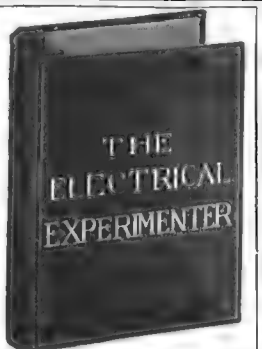

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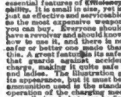

Place a very small amount of this powder on the back of your hand and blow it into the air, and everyone in the room within the carwill begin to sneeze without knowing the reason why. It is most amusing to hear and see a person sneeze, as they never suspect the real cause, but think they have caught it one from the other. Between the laughing and sneezing you yourself will be having the time of your life. For **parties, political conventions, ear rides,** or any place at all where there is a gathering of people, it is the **greatest joke** ever. Price 15c or 2 for 25c.
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With a bunch of these bills, it is easy for each person of limited means to be a poor prosperous. By flashing a roll of these bills at the right moment, and peeling off a genuine bill or two from the outside of the roll, the effect created will be found to be all that can be desired. Each bill is a perfect fac-simile of $100 bill. Price 10c per 100.
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You may have a lot of fun with this Sparkling Gem Squirt Ring. It consists of a ha-dsome gilt plated ring, attached to a rubber ball, so arranged that the latter is quite out of view when the ring is in the proper position for wearing. The live looking ring at once cannot fail to be the center of attraction. While the water is absorbed in giving a cl ear view, you just squeeze the rubber ball and the observer experiences a very great surprise. **PRICE 20 CENTS.** Three for 50 cents postpaid. **J. & S. CO.**

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ANYONE CAN DO THEM

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WRITES WITH WATER Dip. Makes 14 ink. Writes as well as any fountain pen. Will drive any writing fluid. Writes on a drop as well as an ordinary pen. **Johnson Smith & Co., Dept. E 4, 54 W. Lake St., Chicago**

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Interesting and beautiful little plant, this remarkable plant accurately forecasts the weather many hours in advance. Will grow anywhere and in all seasons of the year. An interesting house plant. Keeps large, fragrant, pink, butterfly shape flowers.

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The Great Japanese Umbrella Palm is a semi aquatic plant, and will grow in a variety of ways. Plant in water or in very damp soil. Probably the most usual, as well as the most interesting method is to grow the plant in a bowl or jar where filled with water, with two or three inches of good garden soil at the bottom. In a few weeks soon commence to g rminate, and the plant shoots up rapidly in the form of a reed. The stems are surmounted by pretty palm-like, appear nce, as shown in the engraving. The tone of the stems is a rich green, and the leaves are of a beautiful shade of green. From the center of the umbrella branch out, and the effect is decidedly novel. The Umbrel a Palm is ideal for table or mantel decoration, and for all decorative purposes, fish bowls, aquarium, etc. We send a liberal package of this novel and beautiful plant, with full instructions for cultivation, by mail, postpaid, **10 cents, or three packages for 40 cents, postpaid.**
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A beautiful ornamental vine with lovely green foliage, is trembling leaves, showing massed clusters of shaped flowers of delicate pink and white. The effect is most charming, the tubular flowers forming effectively against the bright, clear sky. Easily grown in any window or conservatory. For window d coration, or as an ornamental vine for the garden, it is very pretty and desirable. **Packet, 10 cents, 3 packets for 25 cents, postpaid.**
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A fine plant for small beds, bearing beautiful clusters of pretty lilac, purple and white flowers all over the plant. It has been a great favorite with the ladies for many years. Will grow in any soil. Seeds 10 cents per pkt., 3 for 25 cents.

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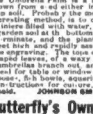
The Great Wonderberry



A luscious berry that grows in bunches and ripened from the green state to a dense purple color. The berries are of the size of a large cherry, and are delicious when ripened. Fine for eating raw, cooked, canned or preserved. Will grow in any soil, and bears from the first season. Is luscious, rich blueberry. One bush will produce enough for a family. Is a wonderful producer of rich fruit all summer and fall. **Packet, 10c. 3 packets for 25 cents, postpaid.**
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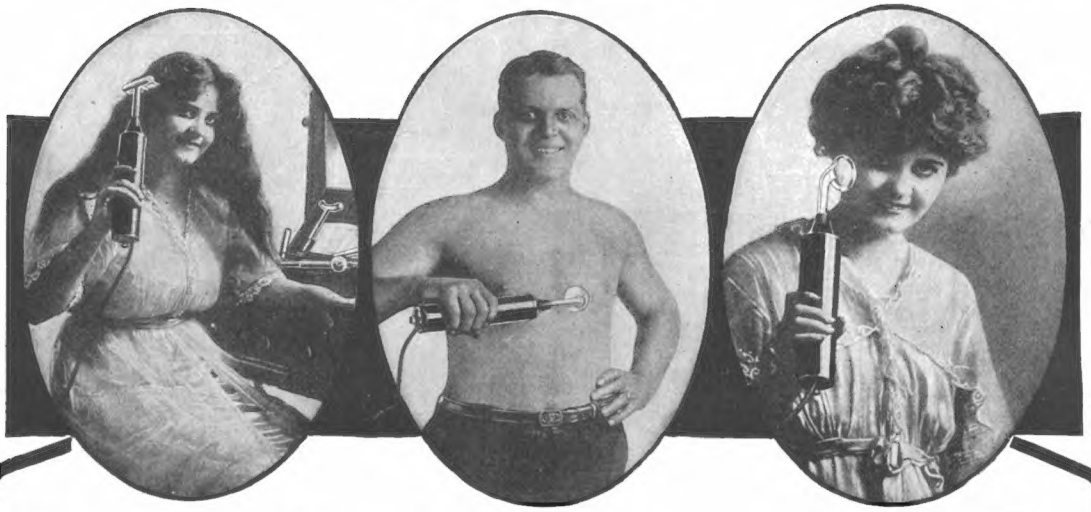

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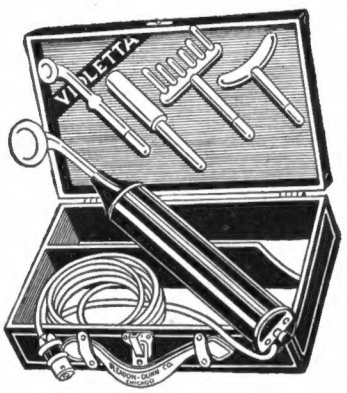

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Not a Vibrator

The wonderful Violetta is not a Vibrator. It is not a machine that contracts the muscles—it does not shock, it does not pound the muscles—it is absolutely painless. Violet-Rays administered by the Violetta are wonderful even for infants! Relieve pain and suffering in every part of the body. Simple tests prove that Violet-Rays pass completely through every part of the body, stimulating every cell and organ. It is electricity in its highest remedial form.

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Here is a partial list of ailments treated successfully, with the Violetta, Violet-Ray Machine.

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Barbers' Itch	Eczema	Pains
Boils	Eye Disease	Paralysis
Blackheads	Falling Hair	Piles
Bunions	Hay Fever	Pimples
Callous	Headache	Pyorrhea
Catarrh	Goitre	Rheumatism
Chilblains	Insomnia	Skin Diseases
Colds	Lumbago	Sore Throat
Corns	Nervousness	Sprains
Constipation	Neuralgia	Tonsilitis
Dandruff	Neuritis	Whooping Cough
Deafness		

What Physicians and Users Say

Trixie Friganza, well known actress, says: "Cheerfully will I add my praise for Violetta. It's the best 'pain chaser' and 'soother' I've had the good fortune to find. It's WONDERFUL. It cured my brother of neuritis. As for myself I use it for facial treatments and general massage. I cannot say too much for it."

Dr. Bert H. Rice, of Vinton, Iowa, says: "I have good results with the Violetta High Frequency Instrument in all cases of neuralgia. Almost instant relief in Facial Neuralgia."

K. L. Allen, D. C., 205 Boone National Building, Boone, Iowa, says: "I have had very good results with the application of High Frequency Current in cases of Paralysis, Rheumatism and Neuritis, and think it a great help in drugless healing."

Dr. Daniels, Lisbon, North Dakota, says: "Have used the VIOLETTA in such cases as Goitre, Bronchitis, Pleurisy, Neuritis, Neuralgia, and Lumbago, and find it very beneficial. In fact, I would not be without it in my office."

Frank Borzone, Seattle, Wash., says: "I purchased the VIOLETTA for my wife who was suffering from an acute attack of Sciatica. From the very first treatment it induced peaceful rest and she is entirely well now."

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